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INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR X353-5B AND X376 FANS

XV-5A

LIFT FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

CONTRACT NUMBER DA44-177-TC-715

GENERAL ELECTRIC

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SECTION 1.

INTRODUCTION

1.1 GENERAL

a. This publication, prepared by the General Electric Company includes installation, operation and maintenance instructions for the X353-5B convertible V/STOL propulsion system. This propulsion system is designed and manufactured by the General Electric Company, Advanced Engine and Technology Department, Evendale, Ohio.

1.2 SCOPE

a. The X353-5B propulsion system (Figure 1.1) consists of a J85-GE-5 turbojet engine (less afterburner) used as a gas generator, a diverter valve to direct the gas flow, and an X353-5B lift fan equipped with vectorable discharge louvers. Reference to the J85 in this publication will be limited to special requirements of the X353-5B propulsion system. Additional information on the J85 engine can be obtained from the Small Aircraft Engine Department, General Electric Company, Lynn, Massachusetts.

1.3 REPLACEMENT OF PARTS

a. Only General Electric Class I, Ia, II or IIa parts are acceptable for use in any X353-5B propulsion system. Replacement parts can be obtained only through the General Electric Company. Inquiries should be directed to:

General Electric Company
Advanced Engine and Technology Department
Lift Fan Systems Operation
Building 501
Cincinnati, Ohio 45215

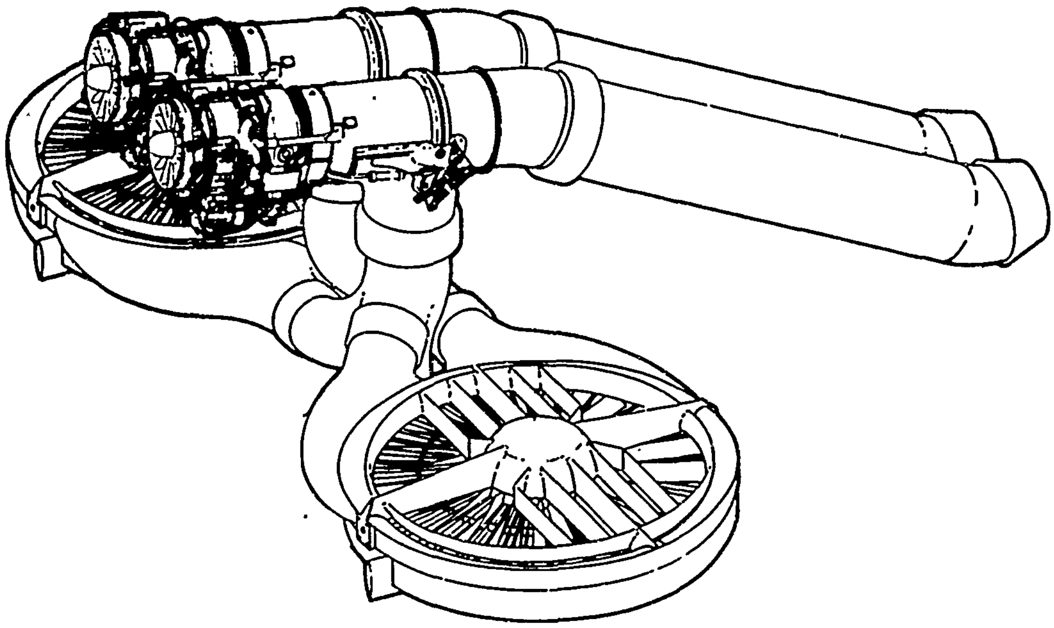

FIGURE 1.1 X353-5B PROPULSION SYSTEM

SECTION 2.

SYSTEM DESCRIPTION

2.1 GENERAL

a. The X353-5B lift fan is designed for installation in the wings of an airplane (Figure 2.1) and combines desirable VTOL features of high thrust, low sfc, low exhaust velocities, low noise levels and low weight. It is a convertible system which augments the thrust of a turbojet engine for vertical takeoff and landing.

b. The J85 turbojet engine and the lift fan are pneumatically coupled by the diverter valve and additional ducting as may be required for a specific installation. For vertical flight, the diverter valve deflects exhaust gases from the turbojet into a tip turbine which drives the lift fan. During transition from hover to horizontal flight, louvers located on the lower surface of the fan vector the fan exhaust rearward to provide horizontal thrust for forward acceleration. Once the aircraft has reached a speed sufficient for wing supported flight, the diverter valve is moved to the straight-through position, the exit louvers and the wing surface over the fan inlet are closed and the J85 turbojet operates in a conventional manner.

2.2 BASIC FAN DESCRIPTION

a. The X353-5B is a light-weight, high-performance, compact V/STOL lift fan propulsion system. The major components (Figure 2.2) include a diverter valve, a single-stage axial flow fan, a power turbine attached to the fan blade tips, a front frame with an inlet guide vane assembly, a rear frame containing the fan and turbine exit stator, a scroll which contains the partial admission turbine nozzle, and exit louvers supported from the rear frame. The leading system particulars are listed in Table 2.1.

TABLE 2.1

X353-5B LEADING PARTICULARS

1. LIFT FAN

Type	Tip turbine lift fan
Type of compressor	Single-stage, co-axial flow
Type of Turbine	Single-stage, impulse, partial admission. Fastened to blades of co-axial fan.
Direction of rotation	Clockwise or counter-clockwise.
Rotor speed (maximum)	2719 RPM (103%)
Installed dimension:	
Distance between wing spar centerline	82.5 inches (cold)
Overall dimension (spanwise)	89.1 inches (cold)
Fan tip diameter	62.5 inches
Depth at hub	18.2 inches
Depth at edge	14.40 inches maximum
Weight (maximum)	915 pounds (includes instrumentation)
Center of gravity	The lift fan C.G. is located 5.3" from fan rotating axis on minor strut centerline and vertically 0.62" above rotor centerline.
Mounting	Three Point. At leading edge, trailing edge and inboard between scroll inlets.

2. DIVERTER VALVE

Type	Tee, with double "butterfly" doors
Basic length	34.8 inches
Basic width	18 inches between mounts, 16.5 inches I.D.
Weight (maximum)	91 pounds (includes instrumentation)
Center of gravity	2.7 inches forward of main mounts, 4 inches below centerline.
Mounting	Integral with gas generator

TABLE 2.1 (Continued)

X353-5B LEADING SYSTEM PARTICULARS

3. LUBRICATION	
Fan bearing grease	Texaco Unitemp 500 or equivalent.
Grease capacity	
Ball thrust bearing	60 grams
Roller bearing	40 grams
Bearing temperatures	350°F maximum
4. ACCESSORIES	
RPM indicating	Magnetic reluctance RPM transmitter
RPM to DC converter	5-1/4" x 9" 5-3/4" transistorized instrument package. 24-28 V. DC, 2a.
Diverter valve position transmitters	Terminal position micro switches. 28 V. DC 5 Amp. resistive 2 Amp. inductive
Diverter valve actuator	Two-position, dual piston. Hydraulic fluid MIL-H-5606, 3000 psi, 2.7 gpm (150 strokes/min.). Design stroke 3.85 in., max. temperature 300°F.

2.3 SYSTEM ORIENTATION

a. Location references used in this text are shown in Figure 2.3. Similar components located on a common diameter around the fan are numbered clockwise starting from the 12 o'clock position. The 12 o'clock position is the forward point of the fan in relation to the nose of the aircraft; this point remains 12 o'clock regardless of the direction of fan rotation. The direction of fan may be either right (clockwise) or left (counter-clockwise) when viewing the rotor from the top looking down. The symbol L (left) or R (right) after the fan assembly serial number identifies the direction of rotation. References to the forward end of the lift fan pertain to the inlet or top side; references to the aft end of the lift fan pertain to the exit or bottom side.

2.4 ROTOR COMPONENT DESCRIPTION

a. The fan rotor component (Figure 2.4) is a single-stage, axial flow compressor which pumps air downward to produce lift. The rotor consists of a shaft and disc, retainer rings, blades, blade platforms, torque band seals, blade shroud covers, blade carrier pins, a carrier assembly which includes turbine buckets, and carrier tabs.

2.5 Shaft and Disc

a. The rotor shaft and disc (Figure 2.4) are made of SAE 4340 steel. The hollow rotor shaft and each of the two cones that make up the disc are machined from individual forgings to a 0.030" - 0.060" envelope, heat treated, and final machined except for surfaces affecting final assembly tolerances. The two cones are bolted together with 36 tie bolts at the outside diameter to form the rim of the disc. The cones are shrink-fitted to the shaft to form a permanent disc-shaft assembly. Final machining of assembly surfaces and broaching of the blade dovetail slots completes the disc-shaft assembly.

2.6 Blade Retainer Rings

a. Each rotor assembly has two blade retainer rings (Figure 2.4). The rings are bolted one to each side of the disc rim; they prevent axial translation of the blade dovetails and provide attachment for the blade platforms. The rings are formed of 0.045" 17-7 PH sheet and contain 36 holes around the circumference to accommodate the tie bolts. Thirty-six equally spaced tabs (stamped from 0.022" 17-7 PH sheet) are spot welded to each ring; an anchor nut is spot welded to each tab to provide an attachment for the blade platforms.

2.7 Rotor Blades

a. The rotor has 36 blades (Figure 2.4) which pump the air downward to produce lift. The blades have a constant section airfoil and are made without platforms. Each blade is rough machined from either an oversized forging or a hot rolled bar of heat treated PH 14-4 Mo, stress relieved, and final machined. The dovetail and shank are milled and ground to final dimensions. A tang machined on the blade tip provides a hole for a pin attachment to the turbine bucket carrier assembly.

2.8 Blade Platforms

a. The rotor has 36 blade platforms (Figure 2.4) which form the inner aerodynamic flow path through the fan. The platforms and the stiffening braces are formed of 0.028" 61S aluminum. The assembly is spot welded, brazed, and heat treated. Two bolt hole grommets and washers (AMS 5510 stainless steel) are swaged to the platform assembly. The platform assemblies are bolted to the tabs on the retainer rings.

2.9 Torque Band Segments

a. Each rotor assembly has two sets of torque band segments (Figure 2.4), one set is located on each side of the rotor (inlet and exit) between the blade tips and the turbine bucket carrier assembly. The segments transmit torque from the active part of the turbine to the blades which are out of the partial admission arc. Each torque band has six segments formed of R41 stainless steel. Six ears project from each segment; three of the ears contain two holes, the remaining three ears contain one hole. A grommet, machined from R41 stainless steel, is press-fitted into the single-hole ear and is positioned at the center of each carrier; the bolted connection at this point establishes rotor spacing and transmits the torque. The two-hole ears join the ends of the carrier segments and restrict axial displacement; the bolt sizes and torquing standards allow circumferential growth of the rotor.

2.10 Carrier Segment Seal

a. The carrier segment seal (Figure 2.4) forms part of the outer flow path through the fan. The seal is formed in two parts from 0.045" R41 stainless steel. The halves are welded together and slotted to accommodate two blade tip tangs and cover stands. The seals are bolted to the carrier through ears matching those in the torque bands. These same bolts provide the means for assembly of the carrier, seal, cover, carrier tab and torque band. The grommet used to align the torque band extends into the center hole of each seal segment to establish location.

2.11 Blade Shroud Cover

a. The 36 blade shroud covers (Figure 2.4) form the remainder of the aerodynamic flow path at the compressor blade tips, provide an emergency torque transmission system, and carry self-locking nuts to attach the shroud covers and the torque bands and seals to the turbine bucket carrier. The blade shroud covers are formed from 0.015" 17-7 PH sheet, stress relieved, spot welded and heat treated.

2.12 Blade Carrier Pins

a. The blade carrier pins attach the blade tip tang to the turbine bucket carrier. The pins are assembled by select fit and are manufactured in five different sizes ranging from 0.3899" to 0.3914" in increments of 0.0003". The pins (36 to each rotor) are centerless ground to the finished dimensions from R41 stainless steel age hardened to Rc 35 to 43. A portion of the diameter of the pin is contoured to prevent tang fretting. The blade carrier pin is drilled to receive a small radial lock pin.

2.13 Lock Pin

a. The lock pin prevents translation or rotation of the blade-carrier pin during fan operation. The lock pin is machined to a 0.115" to 0.120" diameter from 403 stainless steel, Rc 20 to 26 hardness.

2.14 Lock Strip

a. The lock strip secures the lock pin and holds it in place during fan operation. The lock strip is made of 0.015" 321 stainless steel sheet and has a hole to receive the lock pin.

2.15 Turbine Bucket Carrier Assembly

a. The rotor assembly includes 18 turbine bucket carrier assemblies (Figure 2.4). Each turbine bucket carrier assembly (or segment) consists of 18 turbine buckets, 18 tip shrouds, and a carrier brazed to form a permanent assembly.

2.16 Turbine Buckets

a. The turbine buckets are hollow shells formed to aerodynamic shape from seamless cylinders of 0.015" Inconel X stainless steel. Each bucket contains one stiffener rib running the full length of the airfoil at mid-chord, and two inserts (one at the leading edge and one at the trailing edge), and three bulkhead panels at the root of the turbine bucket. These components are tweezer welded into a sub-assembly and brazed prior to final assembly to the turbine bucket carrier.

2.17 Bucket Tip Shrouds

a. The bucket tip shrouds limit tangential displacement of the bucket tip, act as a bucket vibration damper, provide a radial seal against hot gas leakage across the bucket tip and form the outer flow path for hot gas passing through the turbine. The shrouds are stamped from 0.010" Inconel X sheet and are pierced with slots to accommodate the bucket tip airfoil profile. The shrouds are brazed to the bucket tip during the final brazing of the bucket-carrier assembly.

2.18 Bucket Carrier

a. The bucket carrier forms the inner flow path through the turbine, supports the turbine buckets and provides the means of attaching the tip turbine, fan blades, torque bands, and seals. The carrier assembly consists of two side plates, a cross beam, a yoke, and a platform.

b. The side plates are the primary members of the carrier structure. They are machined from Inconel X stainless steel bar and have a channel shape with tapered flanges.

c. The cross beam transfers the carrier centrifugal load to the blade carrier retainer pins. The beam is machined from Inconel X stainless steel bar stock. It contains a slot to receive the compressor blade tip tang and is drilled to receive the blade retainer pin. In certain assemblies, the side rails and the cross beam may be machined as one piece from a rolled Inconel X bar.

d. The yoke is formed from 0.010" Inconel X sheet and serves as a stiffener and attachment point for the bucket root.

e. The platform is brazed to the top of the carrier and forms the inner flow path through the turbine. It is formed of 0.015" Inconel X sheet and is slotted to accommodate the turbine bucket airfoil profile.

2.19 Bucket Carrier Tabs

a. The bucket carrier tabs (Figure 2.4) link the carrier segments together and eliminate blade tip twist during operation of the fan. The tabs also serve as part of the emergency torque transmission system. The tabs are machined from 0.045" Inconel X stock and are solution treated to Rc 32 to 40 hardness.

2.20 Balance Weight

a. The balance weights are assembled to the rim of the disc as required to balance the rotor. The weights, machined from L605 stainless steel, have an allowable weight range between 26.5 to 28.0 grams and are assembled to the bolt between the retainer ring and nut.

2.21 Tie Bolts, Washers, and Nuts

a. The disc tie bolts (36 to each rotor) are machined from SAE 4340 steel hardened to Rc 38 to 40. The threads on both ends of the bolt are 0.3125-24UNF-3. The body of the tie bolt is ground to 0.3110" to 0.3130" diameter and is 2.250" to 2.258" long. The end of the bolt toward the inlet side of the rotor has a single undercut; the end toward the exit side of the rotor has a double undercut and has a shoulder 0.340" to 0.350" diameter by 0.050" to 0.060" high.

2.22 FRONT FRAME DESCRIPTION

a. The front frame (Figure 2.5) forms the aerodynamic flow path to the rotor inlet and serves as the mounting and support structure for all other fan components. The frame is constructed of 17-7 PH sheet and forgings.

b. The basic sub-assemblies of the front frame are the hub, two major struts, two minor struts, and four bellmouth sectors. The front frame sub-assemblies are permanently joined with fusion welds. The major and minor struts are first joined to the hub; then the bellmouth sectors are joined to the hub and strut assembly. The entire unit is heat treated prior to final machining.

2.23 Hub

a. The hub, which forms the inner flow path to the rotor, houses both the ball bearing and roller bearing which support the overhung rotor. It also mounts the closure doors and closure door actuating accessories. The ball bearing housing and roller bearing support flange are machined from forgings. The housing and flange are connected with a cylinder formed from 0.032" sheet. The outer skin of the hub (or bulletnose base) is formed in two 180° sections from 0.032" sheet. Sixteen gussets of 0.032" sheet attach the bulletnose outer skin to the bearing housing flanges and center cylinder. The top plate is machined from a forging to 0.090" thickness and is concentrically located on the roller bearing support flange. Four pads and supporting brackets are keyed into the top plate and serve as an attachment location to accommodate an aircraft inlet closure system. Additional stiffeners at the 3 o'clock support strut position are made from 0.180" sheet; those at the 9 o'clock support strut are made of 0.062" and 0.125" stock. The stiffener around the bottom side of the bulletnose is formed from 0.032" sheet. The entire assembly is a fusion weldment except for: spot weld attachment of the gussets and bulletnoze stiffeners, and for the rivet attachment of the bulletnose skin to the sixteen gussets.

2.24 Housing - Roller Bearing

a. The roller bearing housing is rough machined from an AMS 5643D forging, hardened to Rc 35 to 42 and finished machined. The roller bearing is rabbeted in the roller bearing housing frame flange to assure proper alignment of the housing and to form a strut tensile load transfer joint. A locating pin on the aft face of the housing matches a slot in the roller bearing grease shield and holds the shield in place.

b. The housing has three circles of bolt holes. The outer circle has a total of eleven holes: eight of these are equally spaced and accommodate bolts which fasten the housing to the forward flange of the front frame; the remaining three holes are tapped with 0.250 - 28UNF-3 threads and serve as a puller attachment point. The eight holes in the intermediate circle are equally spaced and contain 0.190 - 32UNF-3 threads to accept bolts which fasten the roller bearing retainer to the housing. The four holes in the innermost circle are equally spaced and contain 0.250 - 28UNF-3 threads which serve as an attachment for the end cap of the instrumentation slipring.

c. Three 0.062" holes through the length of the housing and through the side wall accommodate bearing thermocouple leads.

2.25 Bearing System

a. A two bearing system consisting of a ball thrust bearing and a roller bearing, supports the overhung rotor. Both bearings are mounted in the front frame hub. The ball thrust bearing is mounted near the forward face of the disc; the roller bearing is mounted near the end of the shaft. The balls, rollers, and races are made of 52100 steel; the cage material is silver-plated bronze.

b. The bearing inner races are press fitted to the rotor shaft at assembly. The ball bearing race is locked in place with a threaded nut and lockwasher. The roller bearing is retained only with a tab washer. Both outer races have a light press fit into their respective housings in the front frame, and are secured with bearing retainer disc's and bolts.

c. The thrust bearing is a ball bearing with a split inner race. The bore diameter of the bearing is 110 mm. The tolerance of the bearing is ABEC-5 grade (aircraft quality). It contains 14 balls which are 1.125" in diameter. The ball bearing is designed to give 600 hours B10 life at a maximum temperature of 350°F when lubricated with grease.

d. The roller bearing bore diameter is 80 mm with tolerance of ABEC-5 grade (aircraft quality). It contains 18 rollers 16 x 16 mm. The roller bearing is designed to give 600 hours B10 life at a maximum temperature of 350°F when lubricated wit[illegible] ase.

e. The rotor bearings are grease lubricated which minimizes maintenance problems and helps attain light weight and simplicity since it does not require an oil supply, pumps or lines.

2.26 Grease Seals

a. The grease seals for both the ball bearing and roller bearing are of the lip seal construction which are identical except for their diameters. The ball bearing grease seal is the smaller of the two. Both seals have a polycrylate Sirvene 17660 filler material sandwiched between two thin plates formed from AMS 5510 sheet metal.

2.27 Retainer Seal - Ball Bearing

a. The ball bearing retainer seal is rough machined from AMS 5504D steel to an 0.030" envelope, hardened to Rc 20 to 26, and ground to finished dimensions.

2.28 Grease Shield - Ball Bearing

a. The ball bearing grease shield is machined from 0.040" nominal thick 321 stainless steel. The surface which faces against the ball bearing outer race and the diameters of the shield are precision machined for flatness and concentricity. The inner diameter has a 0.020" minimum radial gap with the ball bearing inner race, thus preventing centrifuging grease from the ball bearing grease cavity.

2.29 Retainer - Roller Bearing

a. The roller bearing retainer is rough machined from AMS 5504D steel to an 0.030" envelope; hardened to Rc 20 to 26, and ground to finished dimensions.

2.30 Grease Shield - Roller Bearing

a. The roller bearing grease shield consists of two identical discs machined to 0.030" thickness from AMS 5510 steel. A thin Teflon disc is sandwiched between the metal discs at assembly. The Teflon disc has a light interference fit with the inner race of the roller bearing. The steel discs are prevented from rotation through use of pin in disc slot.

2.31 Boss - Speed Pick-up Sensor

a. The rotor speed pick-up sensor mounting boss is welded to the cylindrical shell of the hub. The boss is approximately 0.750" in diameter and is located between the 6 o'clock and 9 o'clock positions.

2.32 Magnetic Rotor Speed Pick-up Sensor

a. The rotor speed sensor is of the magnetic variable reluctance type excited by a gear-toothed disc assembled to the rotor shaft. The output signal of the speed sensor is a variable frequency ac voltage; the frequency is proportional to rotor RPM.

b. The speed sensing disc is integral with the ball bearing retaining nut, being machined on its outer diameter. The nut is machined from AMS 6641E steel and is edged with 60 equally pitched teeth.

c. The sensor is assembled to a boss located in the front frame cylinder which connects the roller bearing and ball bearing housings. A threaded sleeve and an end cap hold the sensor in place. The sensor is shimmed radially to control the reluctance gap between the end of the sensor and teeth on the ball bearing retaining nut to within 0.005 to 0.020".

2.33 Struts

a. The two major struts are located at the 12 o'clock and 6 o'clock positions. The two minor struts are located at the 3 o'clock and 9 o'clock positions. The construction of all four struts is similar. The primary members of each strut are the leading and trailing edges; these are machined to constant airfoil shape from bar stock. The side walls are formed from 0.032" sheet and are supported with internal ribs formed from 0.032" sheet. The ribs are welded to both leading and trailing edge caps.

b. An internal longitudinal web made from 0.125" sheet is located at the outward end of each major strut. This web attaches the leading and trailing edge members to the end plate. The end plates serve as mounting pads and are machined to 0.135" thickness at final machining. A shank nut is swaged into each of four holes in each pad. Each strut has two additional 0.032" stiffening gussets (one to each side) at the outward end.

c. A support beam is attached to the outward end of the 3 o'clock support strut. The support beam is attached to a wing member by means of a uniball bearing contained in a housing on the end of the beam. The bottom of the housing is pocketed and drilled to receive a pin thus attaching the center scroll mount to the front frame. The uniball bearing housing is machined from bar stock and is attached to the leading and trailing edges of the strut by two cap beams made of 0.250" sheet. The cap beams are stiffened with two side plates made of 0.062" sheet.

d. The 9 o'clock strut has a longitudinal web made of 0.125" sheet, which protrudes beyond the airfoil section. This web protrusion is sandwiched between two bellmouth gussets of 0.032" sheet providing the strut to the outer bellmouth attachment.

e. Both minor struts have a 1.00" boss located 27" radially from the hub. The boss is machined from bar stock and is welded to the internal ribs and strut side walls. The boss extends through both sides of the strut and serves as a latch for an aircraft inlet closure system.

f. Each of the four struts has mounting pad located at mid-chord near the bellmouth which serves as an attachment point for a circular and fixed inlet flow guide vane assembly. The pad extends through both sides of the strut and two shank nuts are swaged to each side of each pad. The internal plates and stiffeners of this pad are formed of 0.045" and 0.032" sheet and are welded to the strut side walls.

g. Both major struts have a clevis welded to the leading edge. The eye portion of the clevis is machined from bar stock and is welded to the ribs and support members which are formed of 0.032" sheet. The base of the clevis support is welded to the strut leading edge internal ribs and side walls. This clevis provides an outboard hinge mount for the closure system.

2.34 Bellmouth

a. The outer shell of the bellmouth is formed in four segments of 0.015" sheet. These are joined together to form two segments. The segment on the "hot side", or turbine inlet section, is symmetrical about 3 o'clock axis; this section accommodates the turbine inlet scroll assembly. The segment on the "cold side" is symmetrical about the 9 o'clock axis.

b. The two halves of the bellmouth have the same general spot-welded construction. The outer shell is formed from 0.015" sheet and is stiffened internally with 0.030" gussets at 15° intervals around the circumference. A torque tube is formed from 0.030" sheet and is spot welded circumferentially to the 0.015" sheet. Heat shield segments are formed from 0.015" sheet and are attached to the outside diameter of the hot sector. Omegas formed from 0.015" sheet are spot welded to the shield segments to close the gap at their ends. A heat shield formed from 0.015" sheet is attached to the cold side to form the cold side turbine pass tunnel. A shear panel formed of 0.015" sheet is welded to the O.D. of the cold side torque tube, gussets and heat shield. The forward air seal flange, a 360° ring, and the rear frame mounting flange, a 180° arc located in the cold side, are machined from forgings and are assembled last.

c. Two 81° scroll end mounts are located on the hot side of the bellmouth at the 12 o'clock and 6 o'clock positions. The mounting pads are machined to a minimum thickness of 0.090" and are supported by two ribs located in the bellmouth torque tube and by 0.090" thick bracket welded to the strut end mount pads.

d. Four 45° inlet vane support pads are fusion tacked and riveted to the bellmouth outer shell. The support pads are distributed uniformly about the frame circumference and provide vertical shear load support to each inlet vane quadrant at mid-span on the circular vane. Pad material is same as front frame, but pad thickness is 0.060".

2.35 Pin - Support Beam

a. The scroll center mount pin fastens the hot-side strut end to a clevis located on the scroll assembly. The pin is rough machined from AMS 5735 bar, hardened to Rc 25 to 33, and ground to 0.623" to 0.624" diameter.

2.36 Clevis - Scroll Mounting

a. The scroll mounting clevis is machined from Inconel X bar stock and age hardened to Rc 30 to 40. The eye of the clevis has two 0.373" to 0.375" diameter holes to accept the shoulder bolt which pins the scroll to the clevis. Four 0.223" diameter holes in the base of the clevis admit bolts to fasten the clevis to the bellmouth (one clevis at the 12 o'clock position and one at the 6 o'clock position).

2.37 Shoulder Bolt - Scroll Mounting

a. The shoulder bolt which connects the inlet scroll to the mounting clevis is machined from AMS 5667F steel and age hardened to Rc 30 to 40. The shoulder is 1.430" to 1.440" long and has a 0.371" to 0.373" diameter. The threads are 0.3125" -24 UNF-3A. The bolt is lubricated by an "Electro Film Compound" to reduce the resistance to friction during scroll thermal expansion.

2.38 Shim - Scroll Mounting Clevis

a. Shims used to adjust the height of the scroll mounting clevis are made of AMS 5505D material. Shims are supplied in five thicknesses (ranging from 0.002" to 0.020") and the proper shim or combination of shims is determined during trial assembly.

2.39 Forward Compressor Seal

a. The forward compressor seal is a brazed, two-piece, 24-segment assembly consisting of supports and seals. All parts are made of AMS 5510 stainless steel. Each of these segments spans approximately 15°. The support is a three-piece assembly consisting of a shield formed of 0.030" sheet and two seal attachment brackets formed of 0.060" sheet. The shield and the brackets are brazed together and a shank nut is located in the center bracket. The seal is a three-piece assembly consisting of 0.125" Hex 347 SS 0.003 ribbon honeycomb brazed to a backing strip of 0.020" sheet. A mounting flange formed of 0.030" sheet is brazed to the backing strip. A mounting tab formed of 0.030" sheet is spot welded and brazed to the mounting flange end. The seal is bolted to the support using 10-32 bolts.

2.40 Insulation Blanket

a. The insulation blanket is made from Inconel X sheet with an insulating filler material. The outer skin of the blanket is 0.015" thick; the inner skin is 0.003" thick. A doubler flange made of 0.031" material is spot welded to the flange surface of the blanket at the inside diameter. The blanket has twelve sawcuts to minimize thermal growth; each sawcut is supported by a hat section made of 0.015" sheet that straddles each side of the sawcut and allows tangential growth but gives radial and axial restraint. Mounting cups are formed from 0.015" sheet and spot welded to the 0.003" inner skin and overlap the 0.015" skin; 0.205" diameter through mounting holes are located in each cup bottom.

2.41 INLET VANE DESCRIPTION

a. The inlet vane (Figure 2.6) distributes the flow of air to the rotor inlet. The assembly is welded 17-4 PH steel fabrication which is constructed in four quadrants. Each quadrant contains a 90° sector of the circular vane and two fixed vanes (one straight and one angled). At assembly, the ends of each quadrant of the circular vane are bolted to the front frame struts and the inner end of the fixed vanes are bolted to the bulletnose.

b. The construction of the circular vane and the fixed vanes is similar. Both are hollow steel shells butt welded to an end casting or machining at both ends and reinforced with an internal channel-shaped stiffener. The airfoil skins are formed from 0.020" sheet and the internal stiffeners are made from 0.016" sheet. After fabrication the assembly is aged 1100°F for two hours for relief of welding stresses. The castings and machined components are also made from 17-4 material.

c. The 3 and 9 o'clock mounting positions of the circular vane contain a pad assembled with a uniball. This pad and the uniball assembly are bolted into position on the end casting. The 6 and 12 o'clock mounting positions contain a hinged tee which is assembled to the end casting with a shoulder bolt. Each circular end pad contains two holes which match those in the front frame strut and permit assembly of the vane quadrant to the front frame. The 6 and 12 o'clock pads also provide a tang which fits into a slot in the front frame strut.

d. The hub end of each fixed vane has two tapped holes (1/4" - 28") for attachment of the strut to the bulletnose. The ends of the fixed vanes are machined to closely follow the contour of the bulletnose.

e. A uniball bearing is included as part of the circular vane at mid span. A pinned clevis between the vane uniball and the frame support pad provides vertical shear load support for inlet vane aerodynamic and "g" loading.

2.42 SCROLL DESCRIPTION

a. The scroll (Figures 2.7, 2.8, and 2.9) accepts exhaust gas from two gas generators and ducts the gas through two "arms" to the 167.5° arc of the nozzle diaphragm. The scroll has two inlets; each inlet is connected through cross-ducting to both J85 gas generators. Thus, each scroll inlet is designed to accept 50% of the flow of each gas generator. The cross-ducting arrangement separates the flow from each of the engines and permits the fans to continue operating at part speed should one gas generator be shut down.

b. The major components of the scroll are the shell which is stiffened with external hat sections at the inlets, the V-notch clevage between the inlets, and the nozzle diaphragm at the exit. All parts are made of Hastalloy X material and (except the removable variable vanes) are brazed, welded or resistance welded into a permanent assembly.

c. The main shell of the scroll is formed of 0.025" sheet; the portions of the shell which support the ends of the struts and the nozzle partitions are formed of 0.032" sheet. The internal skin members of the V-notch clevage are formed of 0.025" stock; these are stiffened with 10 gussets 0.025" thick and three center gussets 0.045" thick located under the center mounting pad. The external skin over the V-notch clevage (extends from the mounting pad over the gussets to the inner edge of the scroll) is 0.032" thick and is attached to an end plate which is 0.032" thick. The covers at the end of each scroll arm are 0.045" thick.

d. The flanges at the inlets are machined from Hastalloy forgings. The mounting pads are welded to support members made of 0.063" stock. Four shank nuts are swaged to each mounting pad. The pads are finish-machined to a minimum thickness of 0.125".

e. A seal in the form of a 0.188" diameter rod extends around the periphery of the nozzle opening. The seal rod is welded to a support made of 0.032" sheet.

f. The stiffener hat sections welded around the outside of the scroll are formed of 0.032" and 0.025" stock. The sections which support the nozzle partitions and the struts are 0.032" thick; the rest are 0.025" thick. The hat sections which support the ends of the struts are stiffened with 18 internal gussets 0.045" thick. The various portions of the hat sections are vented at various intervals with a hole approximately 0.300" in diameter; each vent hole is reinforced with an eyelet.

g. Three fabricated mounting pads are welded to the top side of the scroll, one at the center of the scroll and one at each end.

h. Three clevises are bolted to the mounting pads at assembly. The clevises are machined from Inconel X bar stock, and each is equipped with a Heim spherical bearing which is held in place with a snap ring. The end clevises appear similar in appearance, but are not interchangeable. The proper location of each clevis can be determined by matching the offset hole in the base of the clevis with the pattern of holes in the scroll mounting pads.

i. The scroll has 18 internal struts (nine to each arm). The struts are fabricated from 0.063" sheet and are brazed in place.

j. The nozzle diaphragm is manufactured either as a right hand (fan rotates clockwise) or a left hand (fan rotates counter-clockwise) unit. This is determined by the number of fixed-position partitions and the angle at which they are mounted in the scroll. A right hand unit contains 69 fixed-position partitions; a left hand unit has 67. The partitions are manufactured in five different families (or airfoil shapes) which have different stock thicknesses. The distribution of the various families of partitions with a right hand or left hand nozzle is illustrated in Figure 2.10; this figure also shows the approximate angle of installation and the stock thickness of each family.

k. The nozzle assembly has a total of 13 adjustable vanes which are assembled between the partitions near the ends of the scroll arms. These vanes are adjusted to trim the flow of hot gas through the nozzle diaphragm (Figure 2.11). In both fans, five adjustable vanes are located near the 12 o'clock position; eight are in the other arm near the 6 o'clock position. The vanes are machined from solid L605 bar; the ends of the vanes are fitted with a sleeve and a lug to support the vane in the scroll. At each vane location, the body of the scroll is fitted with an end cap, sleeve, and threaded boss to receive the vane lug and adjusting shaft. The adjusting shaft extends from the outer side of the scroll passing through the boss and sleeve to the end of the vane. A slot on the end of the shaft engages the end of the vanes to maintain the angular setting. A nut with external threads retaines the shaft axially but permits angular rotation. A lever arm attached to the end of the shaft holds the shaft at any one of four positions.

l. A fuel drain at the lowest point in the scroll provides a means of removing raw fuel resulting from an engine false start, thus precluding the possibility of burning in the scroll assembly.

2.43 REAR FRAME

a. The rear frame supports the fan and turbine stators and the exit louvers, provides turbine bucket tip clearance control, and supports the aft honeycomb air seal. The rear frame is constructed of Inconel X material and is manufactured either as a right hand or a left hand unit. The type is determined by the position and turning angle of the turbine nozzle stator vanes. (Reference Figure 2.12)

b. The major components of the rear frame are: the center pan; 88 fan stator vanes extending radially outward from the center pan; two airfoil-shaped rings which support the stator vanes; 44 turbine stator vanes in the 165^{o} active arc of the turbine; the outer turbine casing; a circular flange which connects the rear frame to the forward frame in the inactive portion of the turbine and carries the turbine scroll seal in the active portion; and an exit louver support strut extending radially across the rear frame from the 12 o'clock position to the 6 o'clock position.

c. The center pan consists of an 0.025" dished skin which is welded to the exit louver support strut. The center pan is stiffened on the aft side with hat radially positioned sections made of 0.020" sheet. The ring near the hub is formed of 0.060" sheet and is reinforced with an 0.020" doubler. The doubler plate at the bottom center of the hub is 0.025" thick.

d. Eighty-eight compressor stator vanes extend radially out from the center pan. The vane skins are formed of 0.020" Inconel X. Each vane has an internal stiffener of 0.020" stock and two end inserts of 0.080" stock. The vanes extend from a box section of 0.020" stock located at the outer edge of the center pan to the middle box section which is made of 0.030" material. The 45 vanes in the "cold" portion of the rear frame extend entirely through the middle box section; the remaining 43 vanes (those which span the same arc as the turbine section) are shorter and end inside the box section. The skins of these box sections form the inner and outer flow paths through the compressor section and the inner flow path through the turbine. Ninety anchor nuts are riveted to the top side of the middle box section; these serve as a fastening point for the rear frame air seals.

The vanes are supported at two points along their length by two airfoil-shaped support rings.

e. The turbine nozzle has 41 vanes. The vane skins are made of 0.020" Inconel X. Each vane has an 0.020" internal stiffener and two 0.080" end inserts. The inner end of each vane is supported by the middle box section described above; the outer end is supported by an outer box section formed of 0.020" material and the outer skin of the rear frame. The outer flow path through the turbine nozzle is formed by the outer box section which spans the 165^{o} arc of the turbine nozzle only.

f. The outer skin of the rear frame is formed of 0.020" material. The aft flange is formed by an extension of the outer skin material. The forward flange is rough machined from rolled and welded bar stock, welded to the skin, and finish machined. Ninety equally spaced 0.281" diameter holes drilled through the forward flange accommodate bolts for attachment of the rear frame to the front frame and scroll seals at assembly. Twenty-three angular-shaped stiffener hats support the outer skin in the turbine or "hot" section of the rear frame. Seventeen rectangular hat sections support the skin in the "cold" portion of the rear frame. Both hat sections are formed of 0.020" sheet. The outer skin has a total of 34 sawcuts which permit thermal expansion. On the "cold" side of the rear frame, 16 sawcuts pass through the aft flange and outer skin and are stop-drilled about one-half inch below the forward flange. In the "hot" section, 18 sawcuts pass through the aft flange, skin, and almost through the forward flange. A second sawcuts, offset slightly from the one just described, is made in the outer side of the forward flange to a depth where the first cut stops. It is not uncommon for these adjacent cuts to "break through" after fan operation. Breaks such as these will not affect the life or performance of the parts. In fact, the sawcuts would be cut entirely through the flange except that it would interfere with final machining. The sawcuts in the "hot" section of the rear frame are covered with omega sections made of 0.015" sheet.

g. In the "cold" portion of the rear frame, 17 gussets of 0.020" material extend from the outer skin to the intermediate box section. In this same arc, a channel plate of 0.025" material extends from the middle box section to the outer skin. This channel, or cover plate, closes off the "cold" portion of the turbine nozzle. The cover plate and the outer skin of the rear frame are pierced with holes to accommodate bolts and nuts to fasten the rear frame inner insulation blanket at assembly. A tab of 0.020" sheet is spot welded to these holes for reinforcement.

h. Six clevises fabricated of 0.040" sheet are welded to the outer skin in the "hot" section of the turbine. These clevises serve as an attachment point for the rear-frame-to-scroll adjusting links at assembly.

i. Thirty-seven brackets fabricated of 0.040" sheet are welded to the aft face of the rear frame. These brackets accommodate the exit louver bearing supports. Two pads of 0.140" sheet are welded to each bracket. The pads are drilled with a counter-sunk hole. Shank nuts are swaged to these holes to these holes to provide bolt attachment for the louver bearing supports.

j. The exit louver push rod strut extends across the aft face of the rear frame from the 12 o'clock position to the 6 o'clock position. The outer skin and end caps of the airfoil-shaped strut are formed of 0.045" sheet. The leading and trailing edges are machined from bar stock. The brackets at each end of the strut are machined from bar stock and welded in place. Fourteen bushings are welded to each side of the strut. These bushings accommodate the exit louver actuator linkage.

k. Inconel X doublers have been welded to the ends of the rear frame strut adjacent to the exit louver actuator attachment. The doublers are designed to permit proper actuator load distribution into the strut and eliminate possible panel buckling.

l. A curved Inconel X sheet metal fairing is welded to the sides of the rear frame strut ends. The fairing provides a means of attachment and support of the actuator covers.

2.44 HONEYCOMB AIR SEALS

a. The rear frame honeycomb air seal sectors are made of 321 stainless steel. Each sector consists of a honeycomb seal, a backup ring sector, two gussets, a washer and two spacer bars. The honeycomb is made of 0.003" sheet which is formed into 0.125" hexagonal cells and brazed to the 0.020" backup sector. The sector is reinforced with two gussets of 0.020" sheet. The washer and spacer bars are brazed to the aft face of the backup sector. The diameter of the honeycomb is ground to obtain the proper running clearance during initial assembly.

2.45 TURNBUCKLE - REAR FRAME TO SCROLL

a. Six adjustable links (or turnbuckles) are assembled between the rear frame and scroll. The body of the link is machined from Inconel bar stock and is threaded internally. Each end of the body is equipped with a Heim bearing and two nuts. At assembly, the length of the turnbuckle is adjusted and locked in position with the nuts.

2.46 INSULATION BLANKET - INNER

a. An insulation blanket is bolted inside the "cold" portion of the rear frame bucket channel. The blanket is manufactured in two pieces. One piece butts against the vertical wall of the rear frame; the other piece rests on the plate which seals off the nozzle opening. The skin of the blanket is formed of Inconel X sheet. The skin which butts against the rear frame is 0.003" thick, the other face is 0.015" thick. The insulation filler material has a thermal conductance of 0.62 btu-in/hr-ft^2-^{o}F with a mean temperature of 700^{o}F. Sawcuts at various intervals permit thermal expansion and are reinforced with 0.015" thick internal hat sections.

2.47 INSULATION BLANKET - OUTER

a. An insulation blanket is laced to the outside skin of the rear frame in the hot portion only. The blanket is manufactured in seven pieces and has buttons swaged to the outside skin for lockwire attachment. The skin of the blanket is formed of 0.003" 321 stainless steel material. The filler material has a thermal conductance of 0.62 but-in/hr-ft^2-^{o}F with a mean temperature of 700^{o}F.

2.48 EXIT LOUVER SYSTEM

2.49 Exit Louvers

a. The exit louver system on the X353-5B lift fan has 37 louvers. Although each louver is different, the general method of fabrication is the same. The louvers which are located in the exhaust portion of the turbine nozzle (#1-#14, #26, and #27) are made of Inconel X; the remaining 21 louvers are made of AMS 4026-C aluminum. (Reference Figure 2.13)

b. The shell of the Inconel louvers is 0.020" thick and is spot welded to three internal reinforcing ribs of 0.015" sheet. A spacer of the same material is welded between the skins at the trailing edge of the louver. The end plates are formed of 0.020" sheet. Each Inconel louver has two bearing pins, one extending from the side near the leading edge. The bearing pins are machined from bar stock and are welded to an internal backup plate formed of 0.060" sheet. The backup plate is riveted between the leading edge and the internal stiffener. A second backup plate is fastened between the internal stiffeners. On louvers #1, 2, 13, 14, 26, and 27 an extra pad is welded to the backup plate. The pad is drilled and a shank nut is swaged in the hole to permit bolt attachment of the louver actuator linkage at assembly. The face of the pad surrounding the shank nut is serrated to match the serrated face of the actuator link; this device permits adjustment of the louver position at assembly. Louvers #3 through 12 are slotted at this location for pin attachment to the adjacent aluminum louver at assembly. This pin attachment ties the "outside" louvers to the actuation system and permits gang operation of the louvers.

c. Construction of the aluminum louvers is similar to those made of Inconel. The shell is formed from two layers of 0.030" AMS 4026-C aluminum bonded by epoxy resin and cherry riveted along the "U" channel. The bearing pins which extend from the side of the louver, and the bracket to which it is attached are made of Inconel X material. The bracket is riveted to the internal ribs. A shank nut is swaged to each bracket on the side of the louver which is assembled adjacent to the push rod support strut. The face of the bracket in the vicinity of the shank nut is serrated to match the serrated face of the actuator link. This device permits adjustment of the louver position at assembly.

2.50 Actuator Linkage

a. The exit louver linkage consists of two push rods, a connecting link, a splined shaft, and the actuator lever arm. Each push rod actuates as a unit every other louver on both sides of the center strut. A built-in cam arrangement on the end of the rods permits all louvers to be fully opened or closed by the actuation of one rod.

b. The push rod which is positioned by the forward actuator, is machined from 17-4 PH bar stock while the push rod which is positioned by the aft actuator is fabricated from Inconel X material. The aft push rod has ends which are machined from bar stock and welded to the center channel member. The channel stiffeners and tabs are formed of 0.060" sheet and welded into a premanent assembly. A wear strip along the strut shim side of the push rod is brazed to the side of the push rod. Each rod has seven 0.190" - 0.191" holes drilled through the push rod providing the pin attachment of the splined internal connecting link.

c. The internal actuator lever arm is machined from C50T55-S5 steel and is hardened to Rc 55-70. It has an internal spline of 28 teeth which have a #32 finish. The lever arm has a 0.190" - 0.191" diameter hole in one end which matches those in the push rod for pin attachment at assembly.

d. The splined shaft which fits into the internal actuator lever arm is machined from C50T44-S5 steel and is hardened to Rc 55-70. The center of the shaft is bored to accommodate the louver bearing pin at assembly.

e. The external actuator lever arm is machined from C50T44-S5 stock and is hardened to Rc 55-70. The internal spline matches that of the splined shaft. The opposite end of the lever arm has a serrated face and an elongated hole. The serration matches that on the sides of the louvers and permits louver position adjustment at assembly.

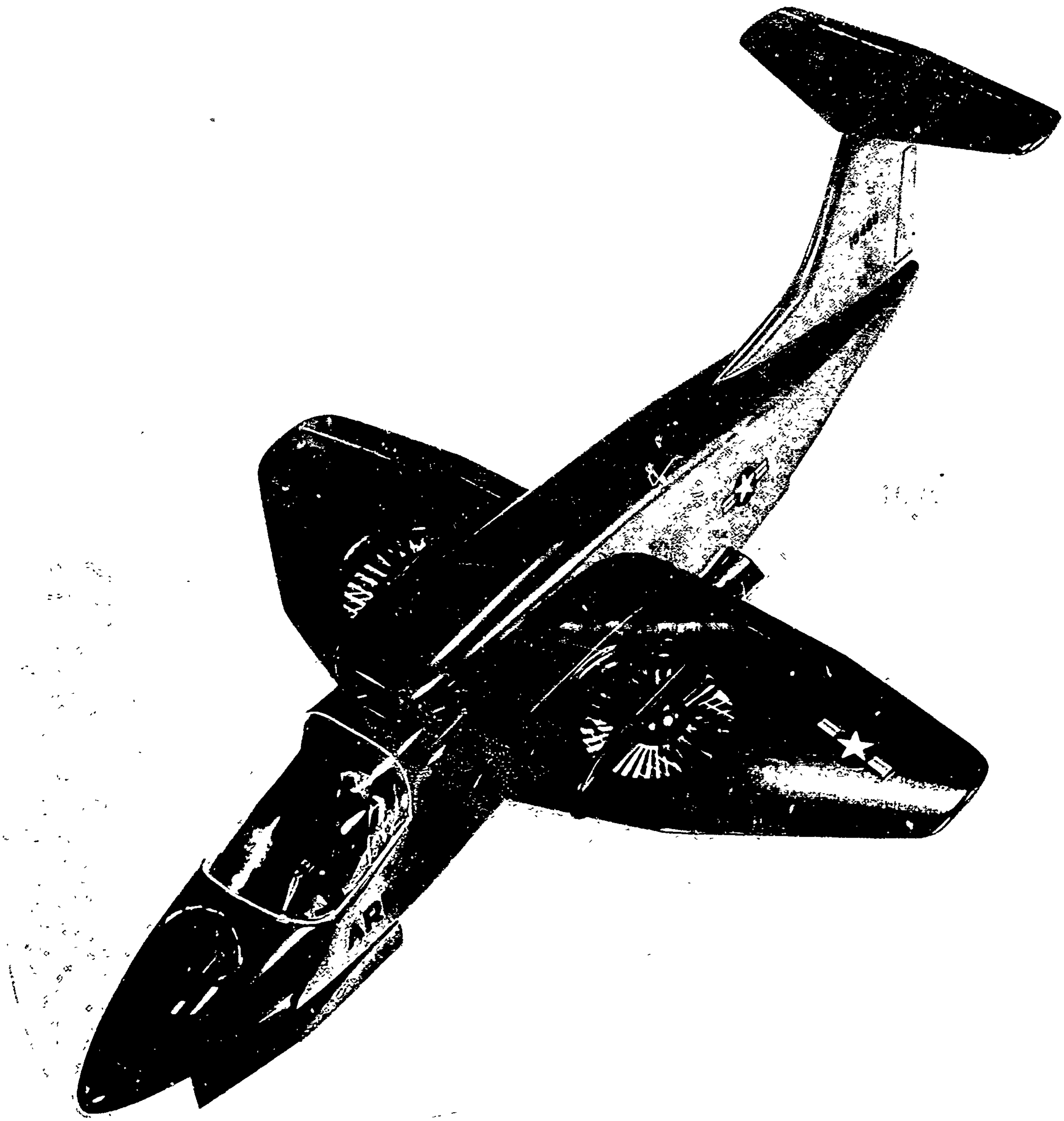

FIGURE 2.1 TYPICAL FAN-IN-WING X353-5B INSTALLATION

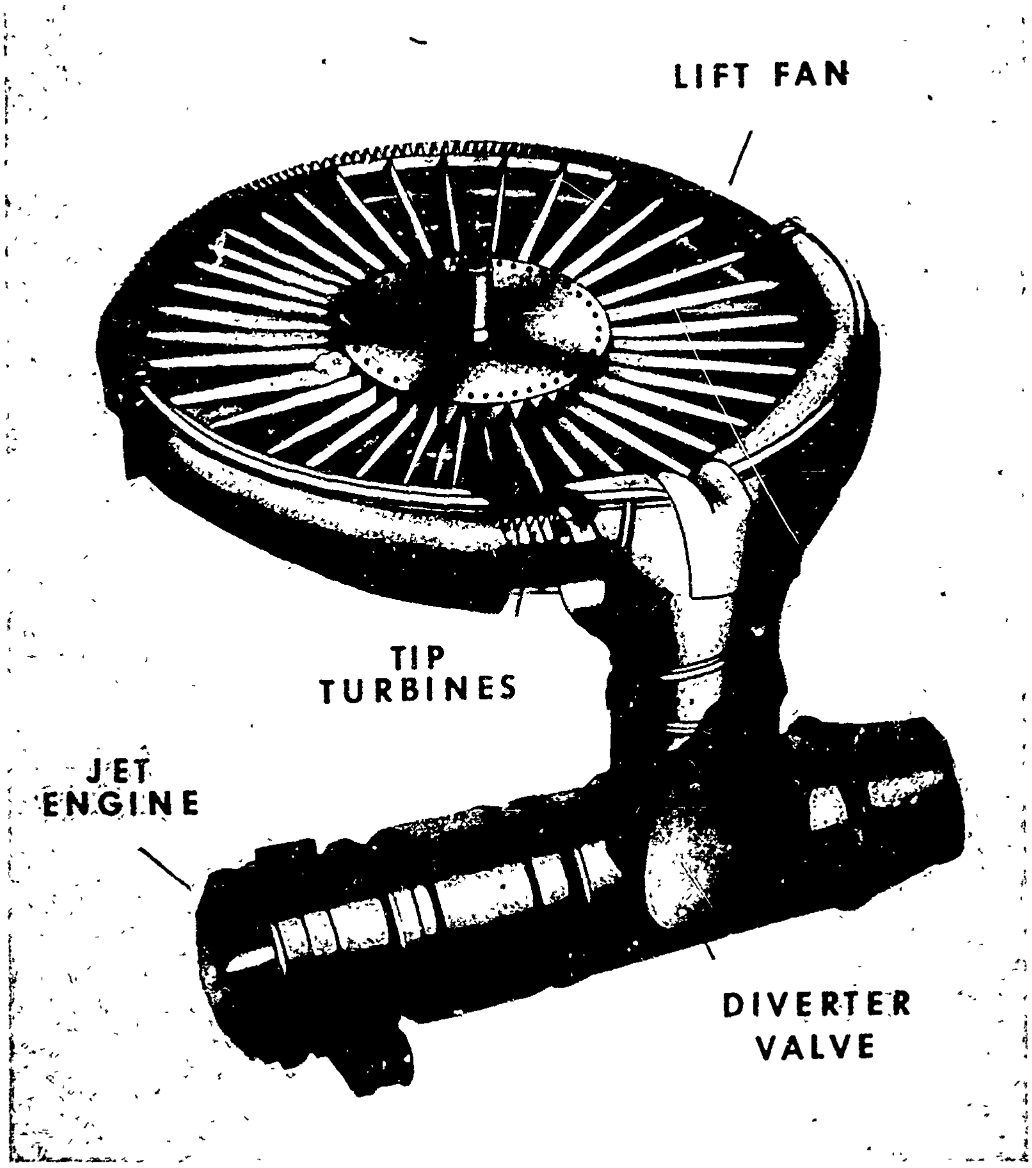

FIGURE 2.2 MAJOR COMPONENTS OF X353-5B LIFT FAN SYSTEM

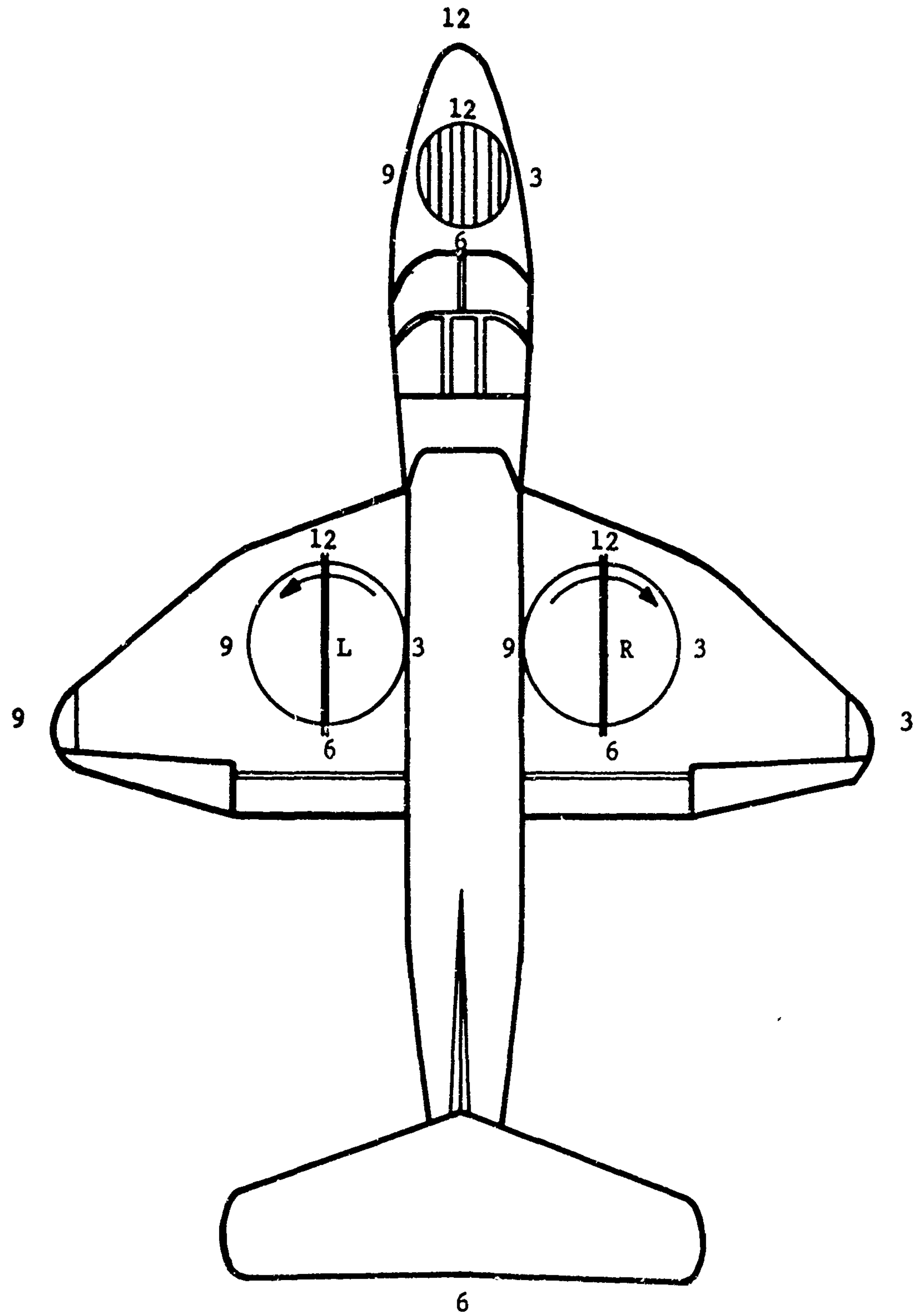

FIGURE 2.3 SYSTEM ORIENTATION

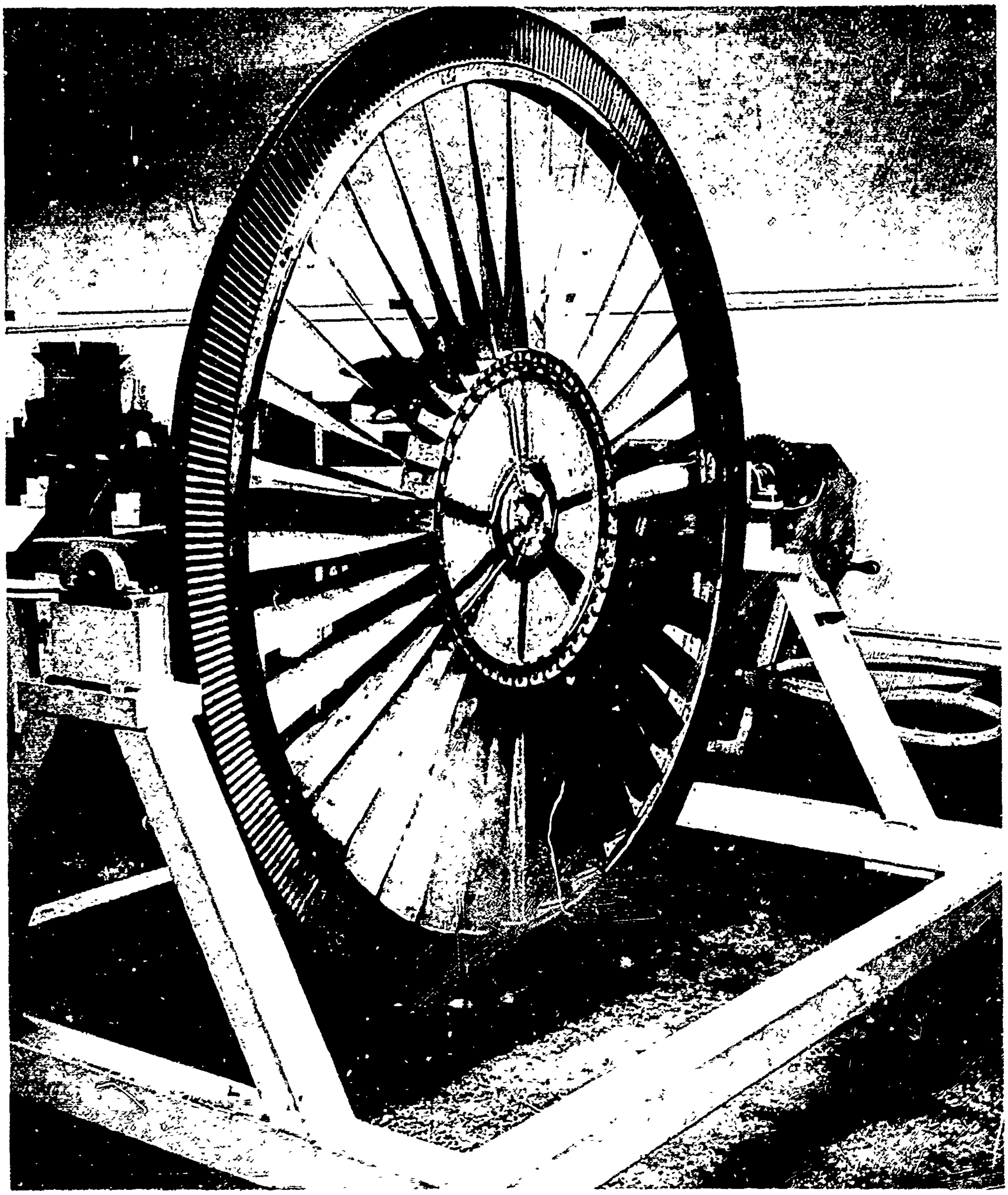

FIGURE 2.4 LIFT FAN ROTOR COMPONENT

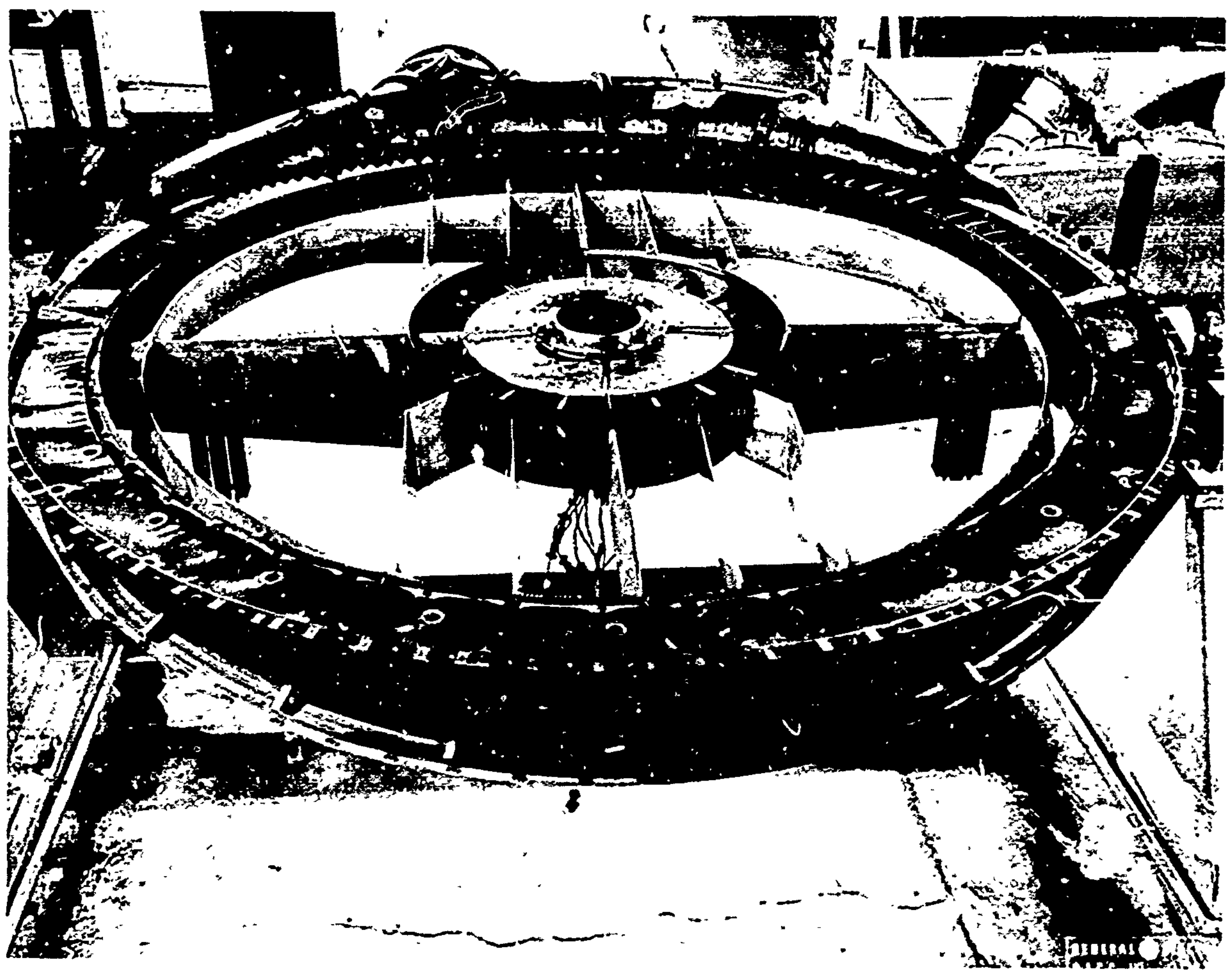

FIGURE 2.5 LIFT FAN FRONT FRAME

25

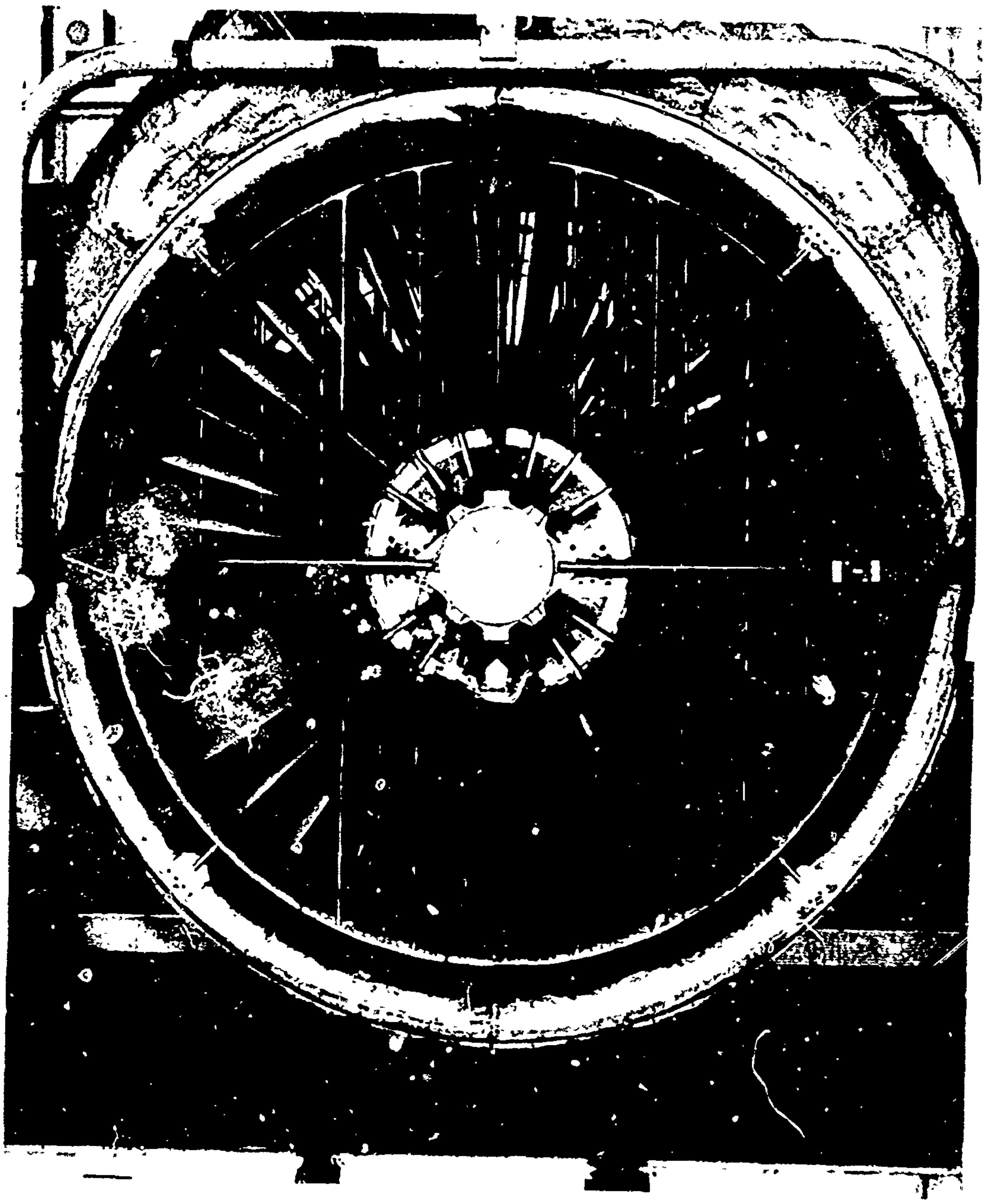

FIGURE 2.6 LIFT FAN ASSEMBLY SHOWING INLET VANE

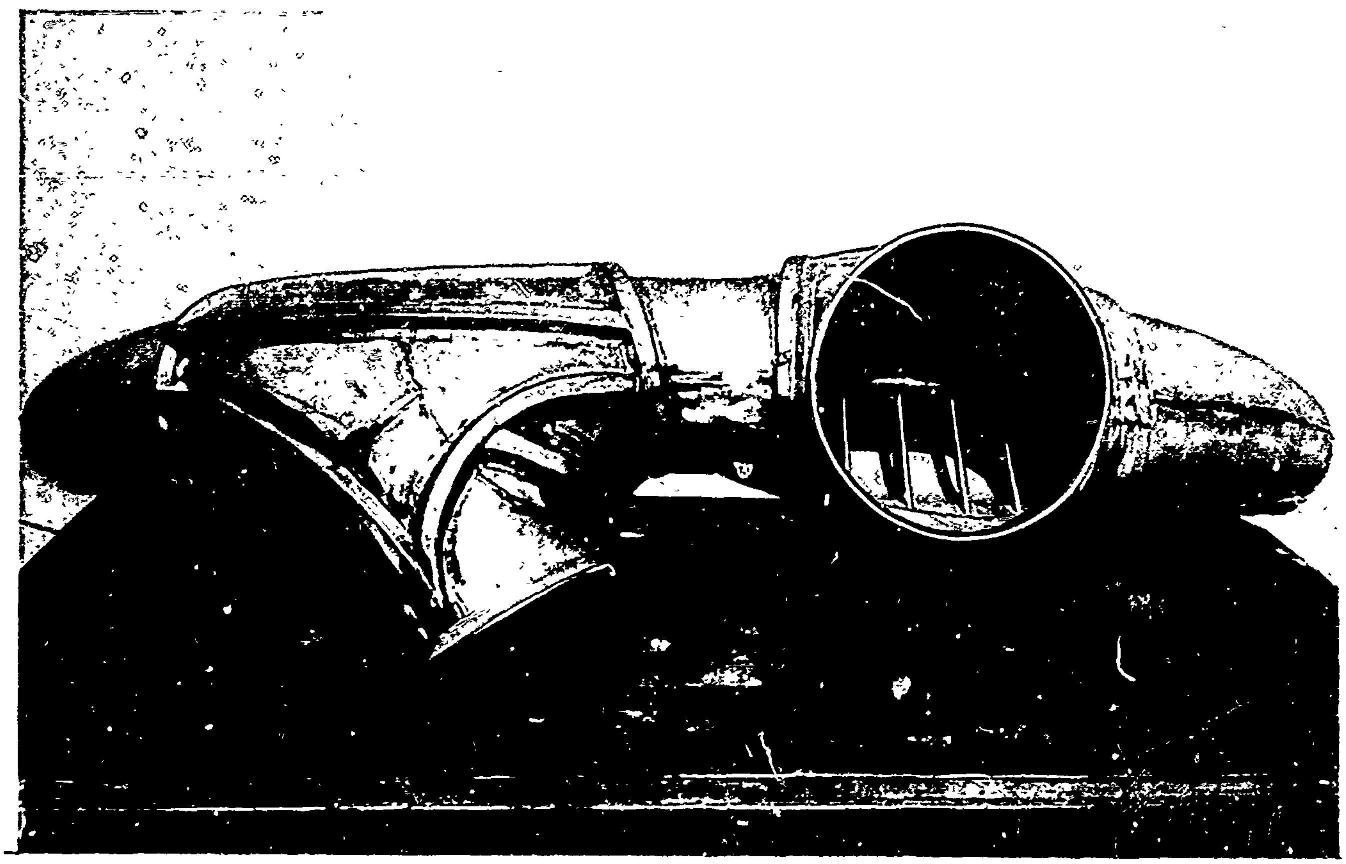

FIGURE 2.7 LIFT FAN SCROLL, VIEW OF INLET

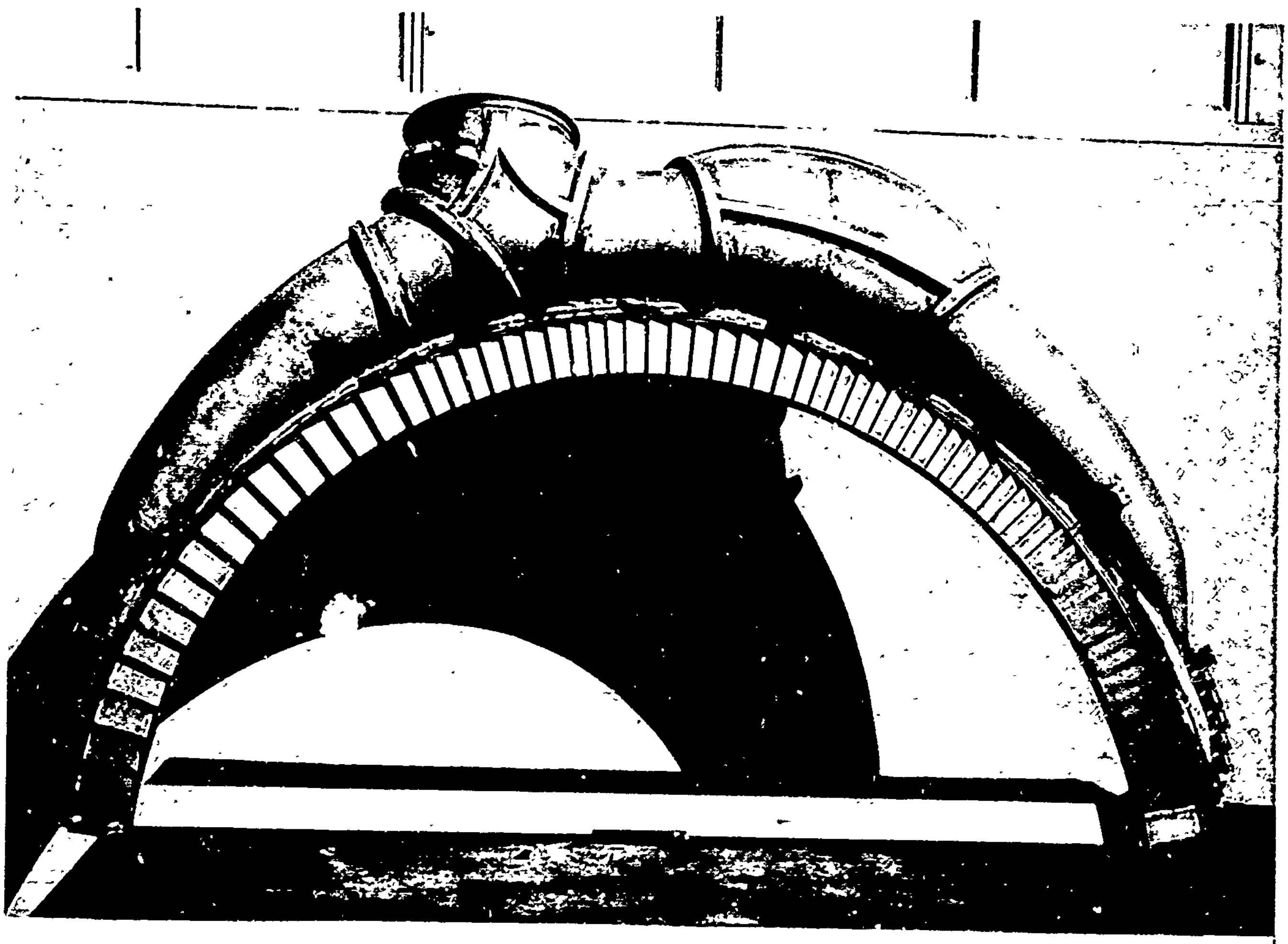

FIGURE 2.8 LIFT FAN SCROLL, VIEW OF NOZZLE

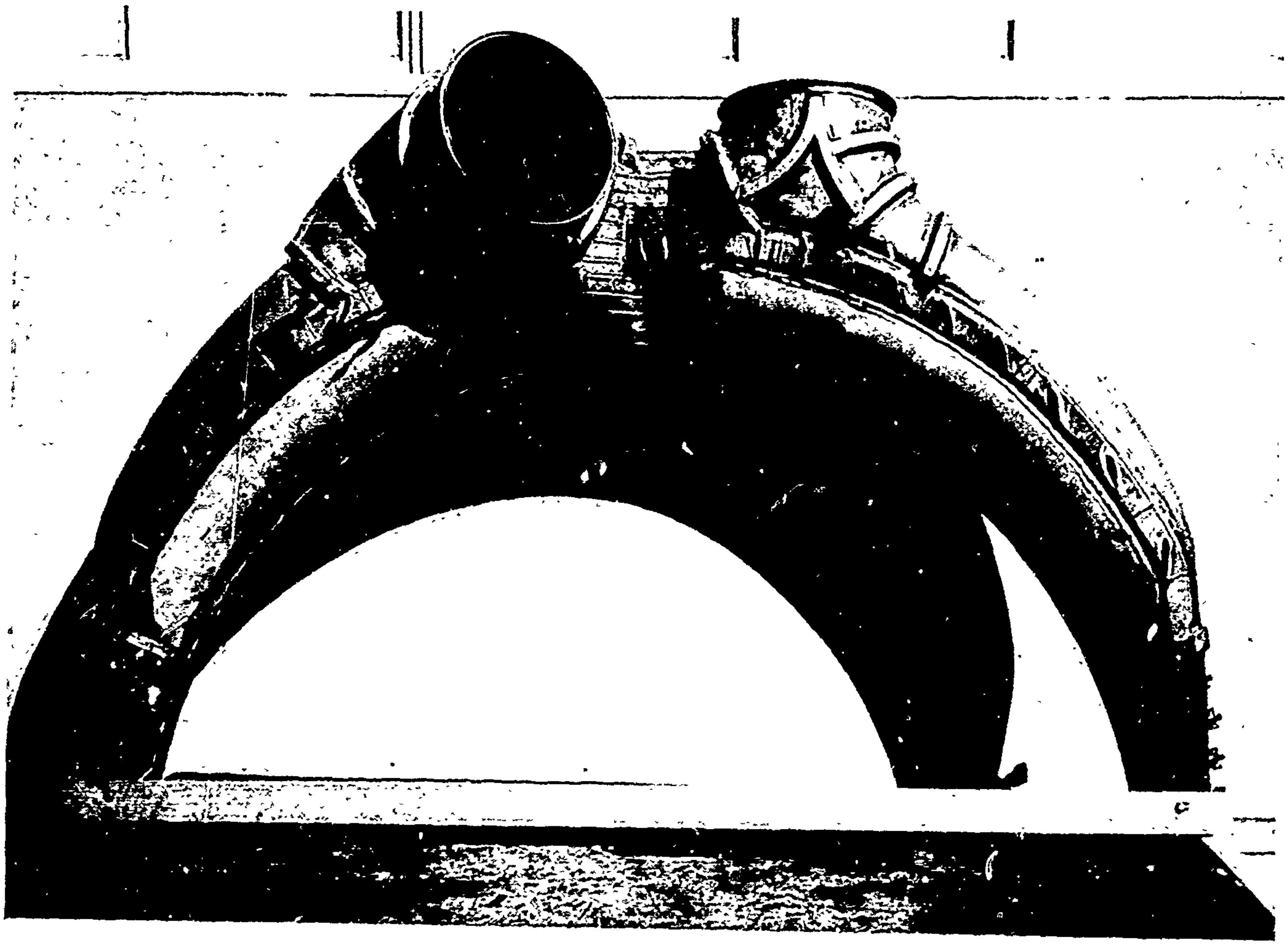

FIGURE 2.9 LIFT FAN SCROLL, TOP VIEW

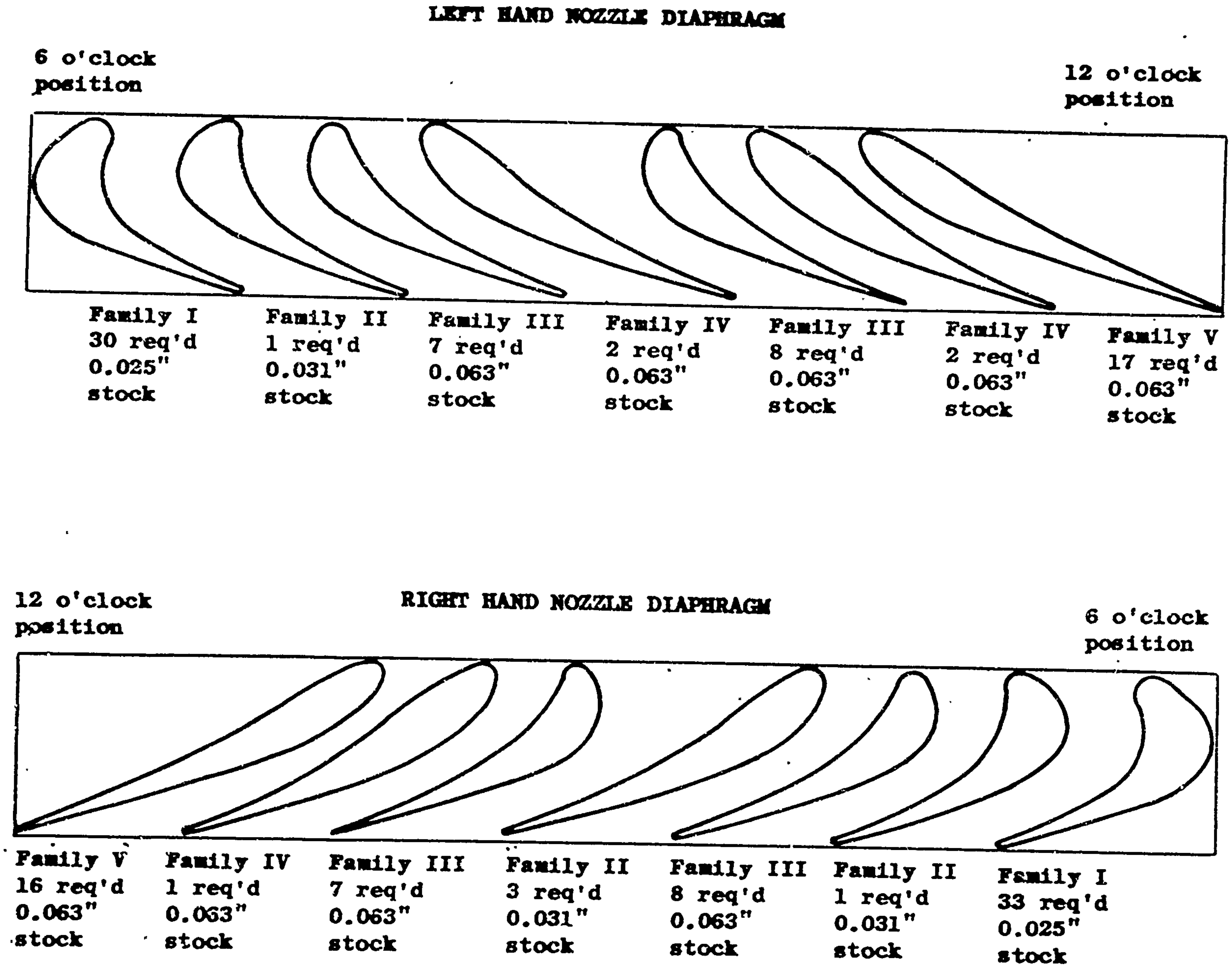

FIGURE 2.10 SKETCH OF TURBINE NOZZLE PARTITIONS

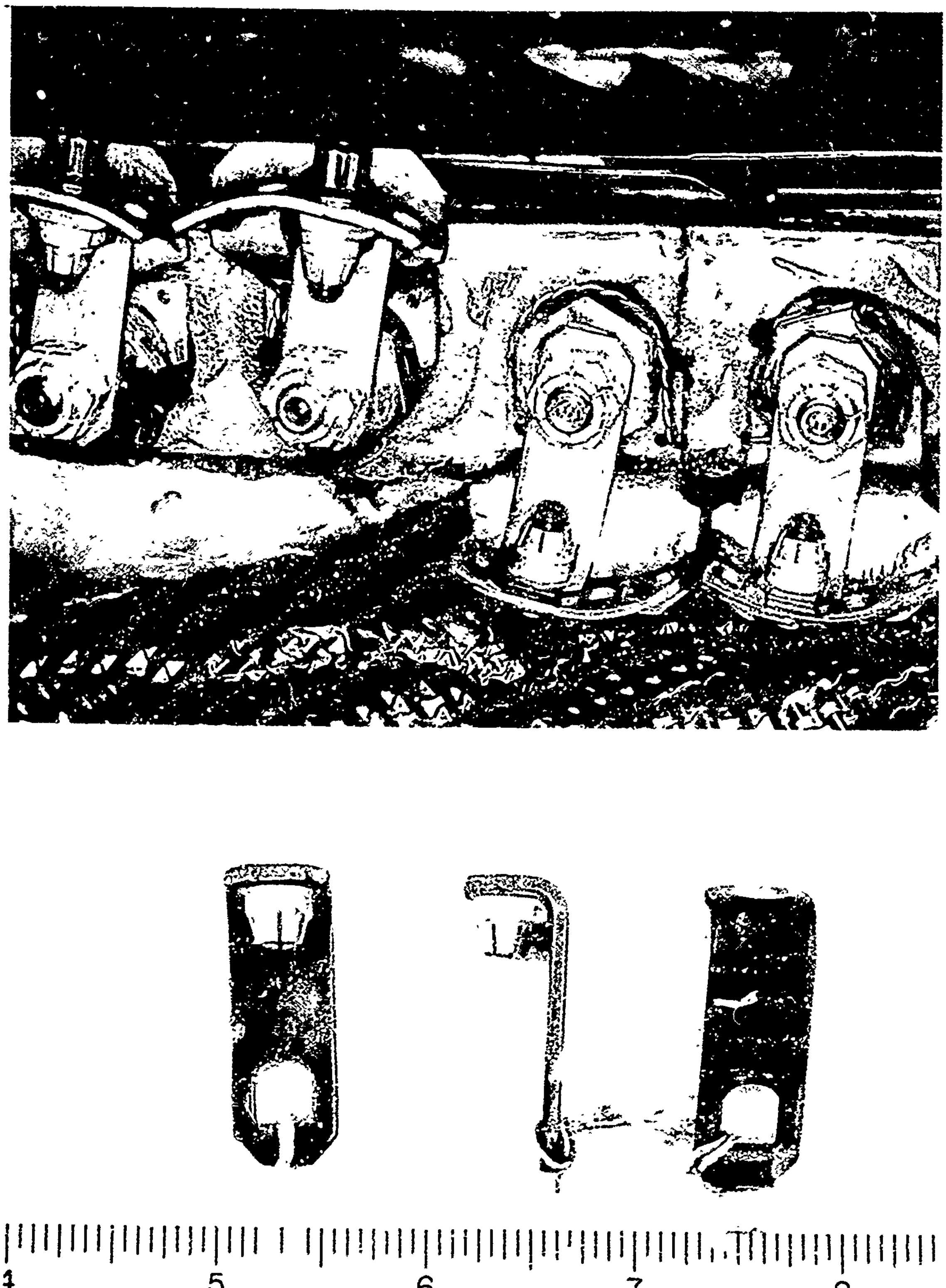

FIGURE 2.11 SCROLL AREA ADJUSTMENT MECHANISM

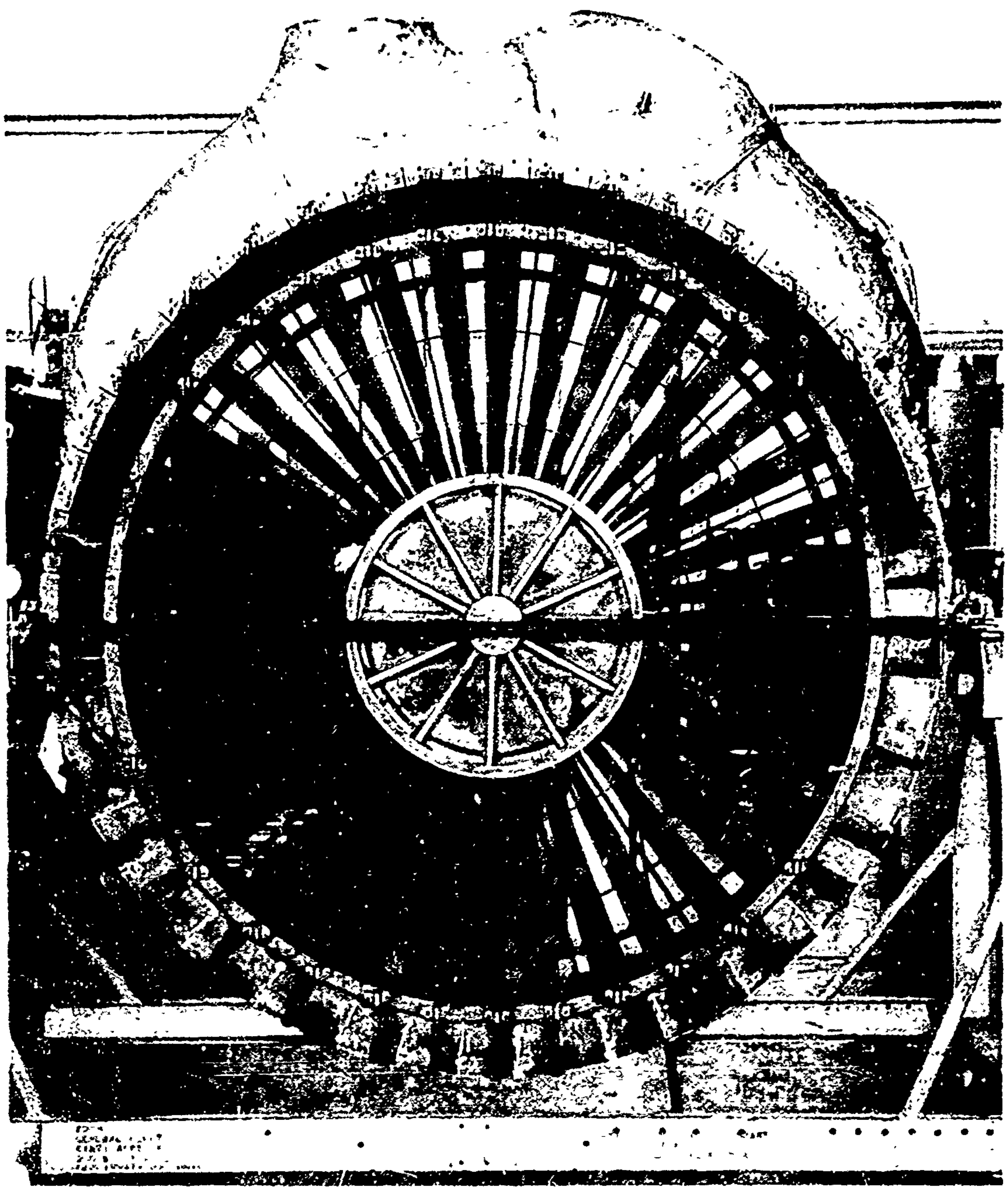

FIGURE 2.12 LIFT FAN REAR FRAME

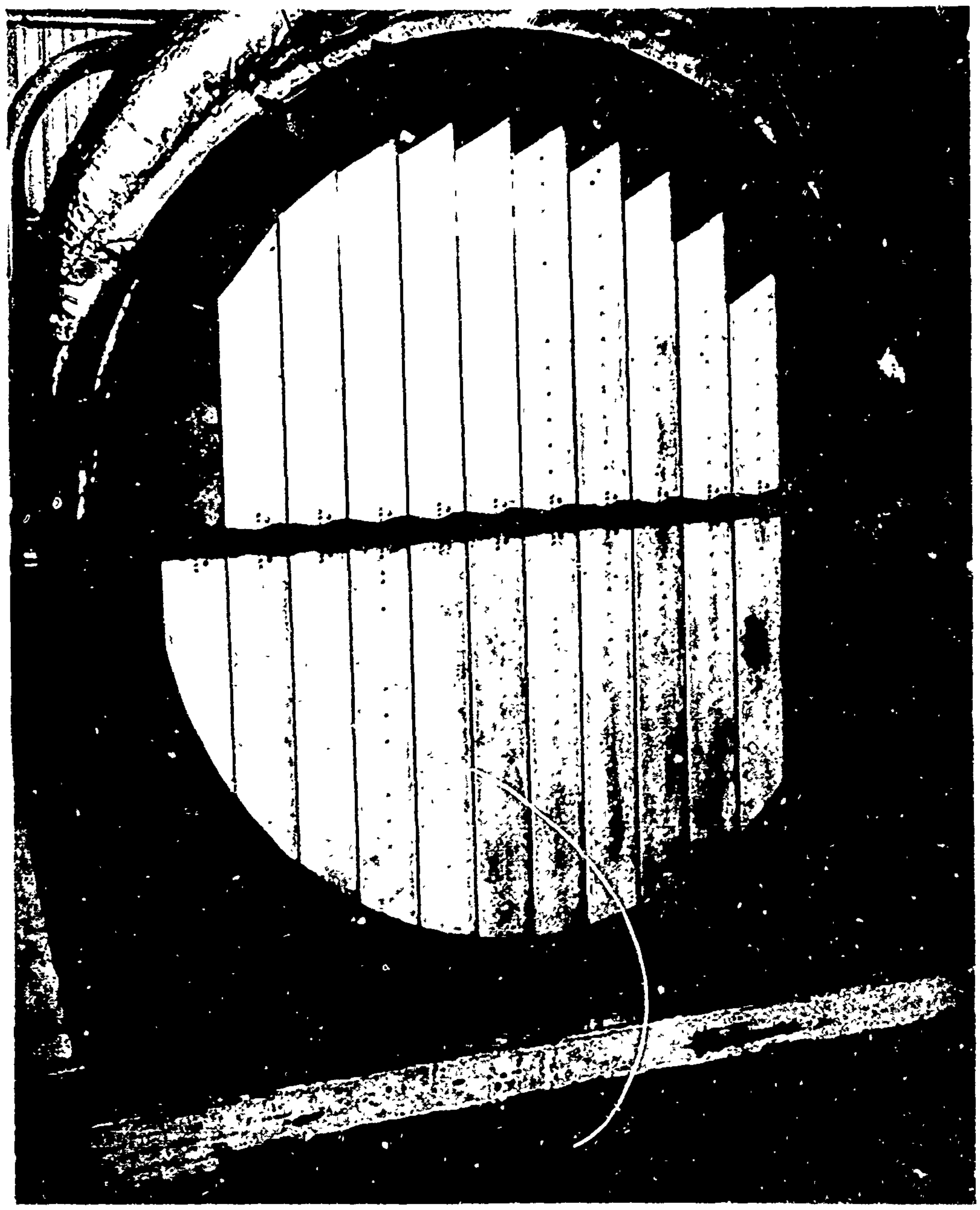

FIGURE 2.13 EXIT LOUVER SYSTEM

2.51 DIVERTER VALVE DESCRIPTION

a. The diverter valve (Figure 2.14) directs the hot turbine exhaust gases from the gas generator either to the X353-5B lift fan (and the X376 pitch trim control fan) or to a conventional fixed engine exhaust nozzle. The diverter valve consists of a valve body, two closure doors, and an actuation system. The valves are not identical and may not be freely interchanged. A schematic of the valve and actuation is shown in Figure 2.15. The diverter valve, with the exception of the actuation system, is constructed from AMS 5536 stainless steel (Hastelloy X). All flanges were rough machined from rolled and flash welded bar stock before welding to the body shell.

b. The closure doors are hydraulically actuated by a set of linkages located outside the shell. When the doors are in the diverted position, the exhaust gases are directed through the diverted leg of the valve to the fan system and the exit to the engine exhaust nozzle is sealed off. In the straight-through (or cruise mode) position, the ducts to the fan system are closed off and the engine exhaust is directed through a conventional exhaust nozzle. Schematics of the actuation are shown in Figure 2.16.

c. The diverter valve body is basically a cylinder and a constant radius elbow blended together to form the bifurcated duct. A semi-elipsoidal centerbody (J85-GE-5 standard part) is supported centrally in the forward end of the cylinder. The 0.032" - thick shell of the body is pierced at two points on each side for door bearings. Also a trunnion mounting point is located on each side of the shell at the intersection of the two duct centerlines. To distribute trunnion loads into the shell, an 0.044" sheet metal pad is seam welded onto each side of the valve body. A stiffening ring half encircles the body and connects to the two trunnion pads; it has an inverted "W" cross-section with only the outermost ends of the "W" attached to the valve body to prevent thermal stress buildup in the shell. A reinforcing panel spans the juncture of the cylinder and elbow so as to better support the membrane stresses in the shell.

d. The trunnion mount itself is a ball-socketed bearing set in a bushing which is welded to the valve body and to the trunnion pad. The center of the ball fixes the point of application of the mount load at a distance of 0.715" from the surface of the valve shell. The two bearings for the forward door are set in die-formed bearing pads located approximately along the centerline of the elbow section. The two rear door bearings are incorporated in the trunnion mount pad. All four bearings consist of hard Stellite #6 bushings pressed into Hastelloy X sleeves which have been welded to the valve body shell and the bearing pad. The bushings are flanged so that they can take both radial and axial loads, thereby permitting use of the valve doors as "tie-rods" to help stabilize the shell against pressure loads. The average clearance in the bearings is 0.020" to protect against seizure. The bearings operate unlubricated at a gas temperature of 1265°F.

e. One entire side of each valve door is made in a single continuous, 0.044" thick skin. The central portion of which forms one flange of a hollow box center-beam. Extending fore and aft from the center-beam, and welded along the continuous skin, are a series of flanged ribs spaced every 1.5 inches. These are made of 0.030" stock in the rear door and of 0.044" stock in the forward door. Each end of the center-beam encases a stubshaft socket block which is bored to a precise diameter so that the stub shaft which supports the door will fit with a minimum of play. A tapered slot at the full depth of the bore provides the means for transmitting torque into the door from the actuator. At the base of the slot, a self-locking flare nut, permanently installed, is used in fastening the stub shaft in place. The entire rim of the door is formed by a 5/8" diameter, 0.045" wall thickness seal tube which provides a housing for door to body seal pieces.

During starting and until the valve door can achieve an equilibrium temperature, a thermal guadient exists between the surfaces and the center of the door. Without protection this gradient could be as much as 800° - 900°F. The pressure side of each door is, therefore, protected from radiation or direct hot gas stream impingement by "heat shields". The "heat shields" are separate, unstressed panels die-formed in two pieces from 0.015" stock, seam welded together, and held in place on the door by interlocking with each other and with the flanges of the ribs. Each heat shield is slid into place between two ribs and secured to the seal tube at one end by tack welds.

f. The seal is an articulated series for metal pieces retained in the slotted tube at the rim of the doors. The seal pieces are made of die-formed parts brazed together. Each seal piece interlocks with the adjacent one by means of a 1/4" long tailpiece. Sufficient clearance is allowed in the tube to permit the string of seal pieces to curve and twist as required to conform to the sealing contour. Contained within the seal tube and under the seal pieces is a one-piece, canted, helical spring made of 0.020" diameter inconel X wire. The pressure of the gas holds the seal piece in contact with the valve body. Since the valve doors are non-circular and not perpendicular to the duct centerlines in their closed positions, their edges make varying angles with the duct wall. The tube slot therefore is a continuous spiral to make a fixed angle to the wall. The seal tube is interrupted only at the bearing block where a 1/2" wide gap forms an assembly slot for seal pieces and springs. This 1/2" gap is sealed by a three-piece tubular seal which is held in place by the duct wall when the door is assembled in the diverter valve.

g. The diverter valve actuation system includes the activating cylinder, the connecting linkage for coordinating door motion, the stops for limiting door motion and the stubshafts which support the doors and transmit the torque. The actuator is a 3000 psi, linear, hydraulic component which responds to pilot commands through a pair of aircraft supplied four-way, three-position, solenoid, hydraulic valves. Reliability requirements necessitate use of the tandem piston actuator with completely separate and independent hydraulic circuits. Positive actuator cooling is provided by incorporating an 0.015" orifice through each piston. The piston rod has a nominal 3/8" female, spherical rod end and joint nut. The "headend" mounting ear contains a 3/8" spherical bearing. Piston rods and sliding surfaces are chromium plated in accordance with MIL-P-6871, type 11. The actuator is designed to operate with hydraulic fluid conforming to Specification MIL-H-5606. The units are designed to be flushed with Specification MIL-O-6083 fluid prior to stocking. Actuators are interchangeable for right and left hand diverter valves. They can be operated satisfactorily throughout an ambient temperature range of 0°F to +300°F and a fluid temperature range of 0° to +300°F. The rate of leakage with 3000 psi working pressure applied should not exceed one drop per dynamic seal per 25 cycles of full stroke actuation; there should be no leakage through static seals. The principal parts of the actuation linkage are the bellcrank mounted on the forward door, the lever mounted on the rear door, and the connecting link between them. About midway along the connecting link is a pin which provides a pivot for two adjustable stop links. The other ends of the stop links are slotted and slide on pins on the bellcrank and lever. Thus, the linkage motion is stopped when either stop link reaches the end of its travel on the pin as shown in Figure 2.16.

h) A mechanical coupling connects the two valves in the system to ensure simultaneous operation in the event of a complete actuator failure on one valve. Unless both valves have the same mode setting (straight through or diverted) a large yawing moment will be imposed on the aircraft from the jet thrust deflectors employed in the control system. The coupling is located between the aft doors of each valve and uses the doors for transmitting the actuation torque. During normal operation,it rotates freely with the doors without transmitting any torque or imposing any stresses in the valves. Free thermal expansion is also permitted and the telescopic action of the torque shaft allows assembly without effecting the valve installation. The torque shaft has a two piece construction and uses eight radial teeth, four equally spaced on each end, for transmitting the torque. These teeth engage in radial slots in the door bushings on each valve. Angular misalignment of the two doors is accommodated by match drilling the two piece torque shaft for a radial shear bolt.

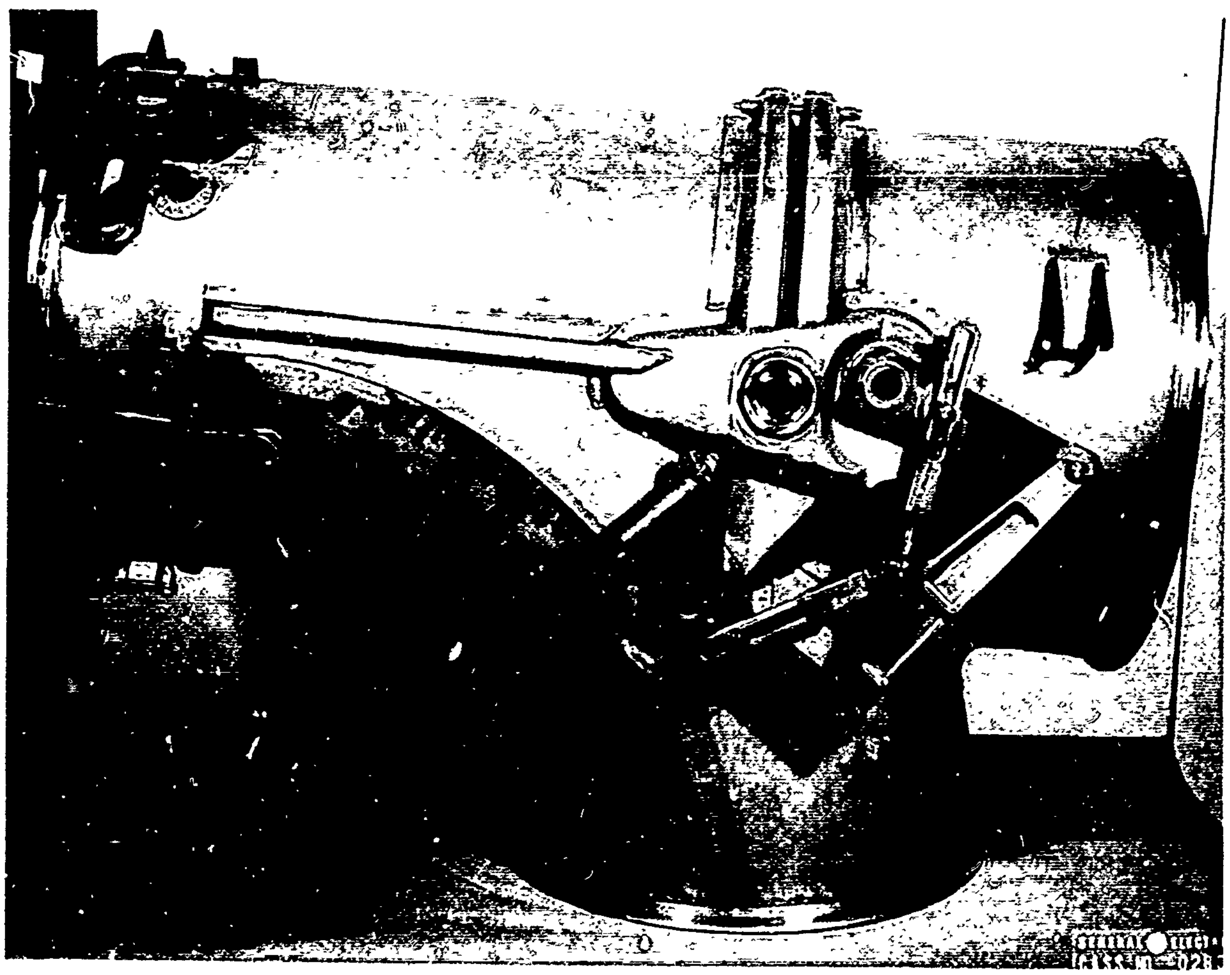

FIGURE 2.14 DIVERTER VALVE ASSEMBLY

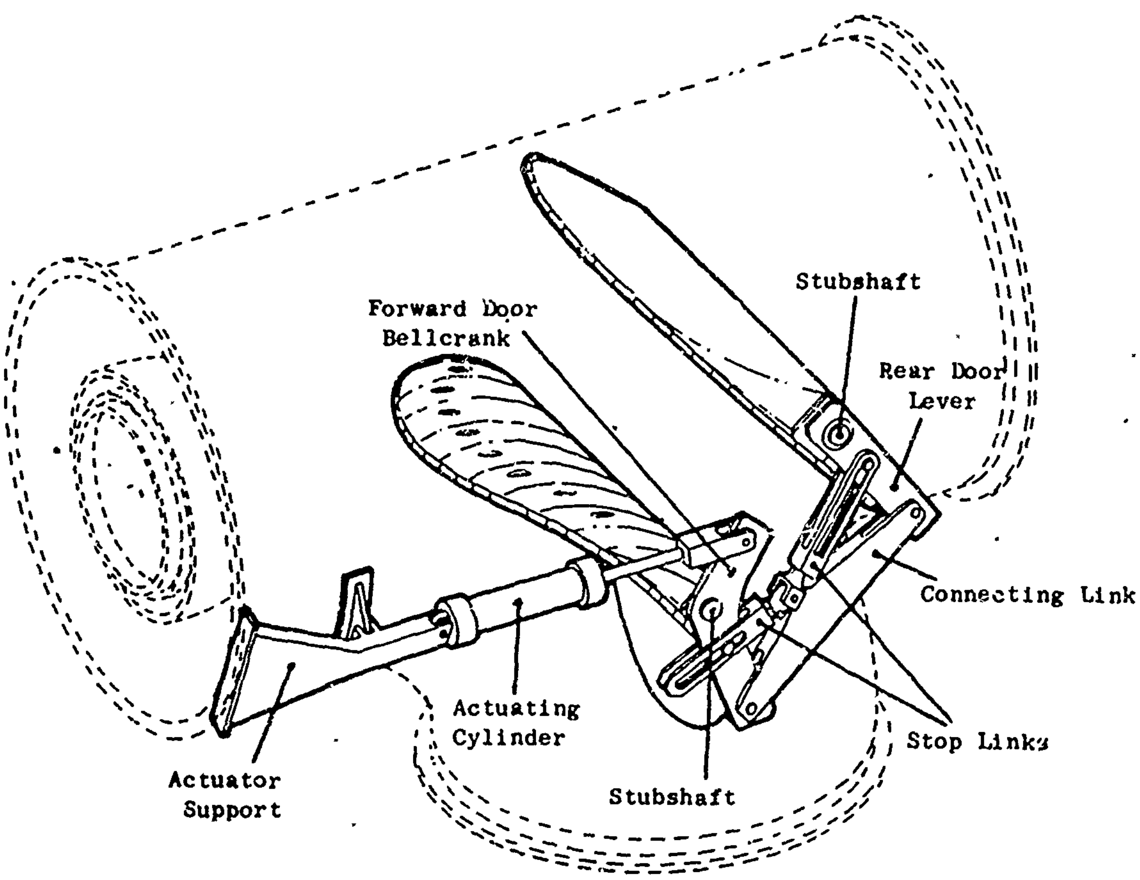

FIGURE 2.15 DIVERTER VALVE ACTUATION SYSTEM

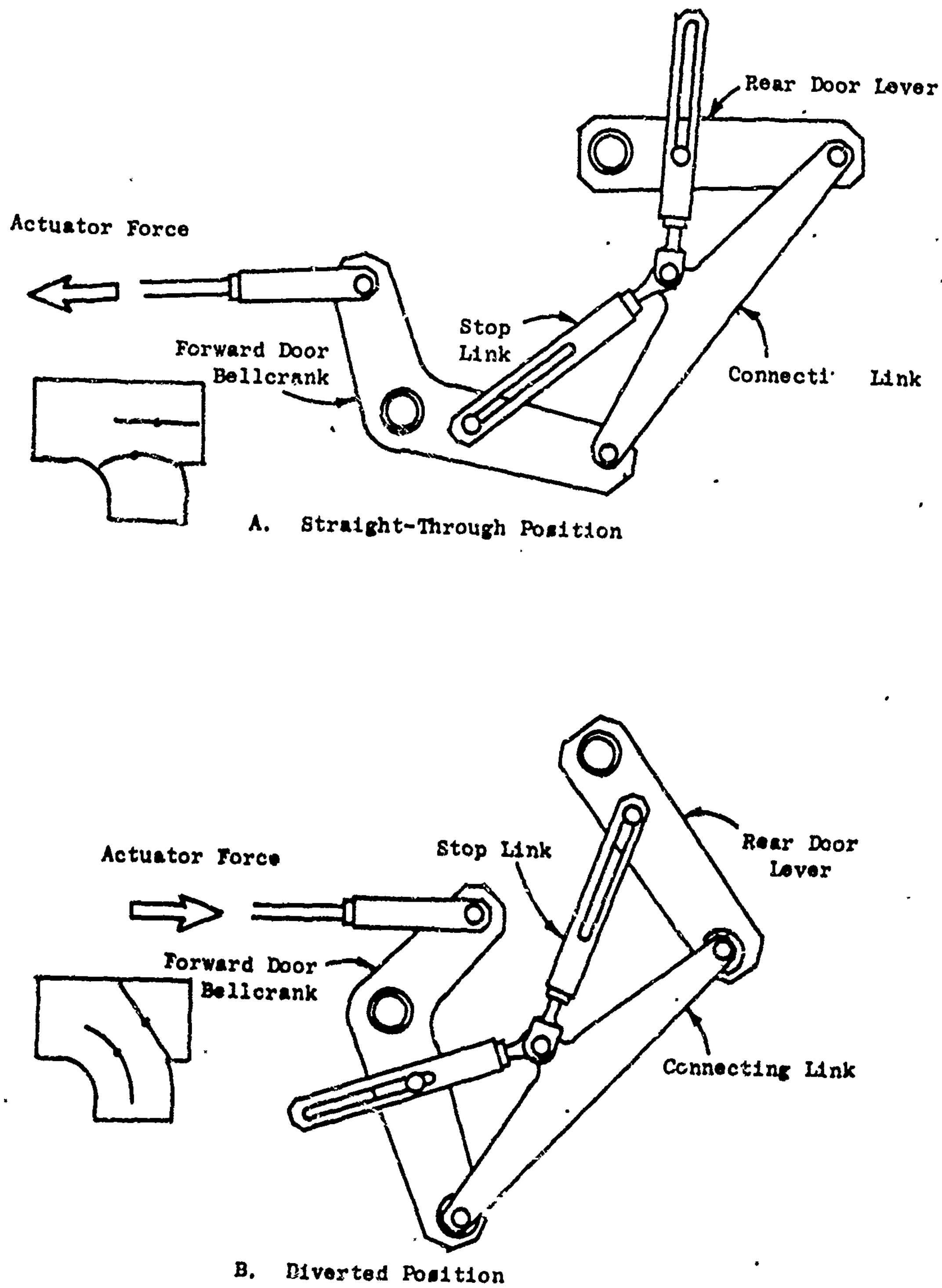

FIGURE 2.16 SKETCH OF ACTUATION LINKAGE IN STRAIGHT-THROUGH AND DIVERTED POSITIONS.

SECTION 3.

SPECIAL TOOLS

3.1 GENERAL

a. This section lists, by function and numerical order, the special tools applicable to work prescribed in this manual. Reference to the tools in other sections of this manual are by the paragraph number indicated in the functional tool list.

b. Use plastic or rawhide (never metal) hammer heads when driving on any part of the fan. Never lift heavy parts by hand. Use a chain or powered hoist and special lifting yokes or straps. Apply pressure or tension evenly to all bearing pushers or pullers. Tighten jack screws and attaching screws, bolts and nuts in small increments (opposing point sequence).

CAUTION

A safety load check should be performed on all lifting devices prior to initial and periodic recheck.

c. The following paragraphs list the special tools. The paragraphs are arranged alphabetically according to part nomenclature and are subdivided on a functional basis. The numerical list of tools follow the functional list.

FUNCTION	TOOL	NUMBER	FIGURE
3.2 BEARING, BALL, INNER RACE			
REMOVAL:	Bearing Race Puller	4012028-612	3.4
3.3 BEARING, BALL, OUTER RACE			
REMOVAL:	Bearing Race Puller	4012026-616	3.8

	FUNCTION	TOOL	NUMBER	FIGURE
3.4	BEARING, ROLLER, INNER RACE			
	REMOVAL:	Bearing Race Puller	4012028-614	3.6
3.5	BEARING, ROLLER, OUTER RACE			
	REMOVAL:	Bearing Race Puller	4012028-617	3.9
3.6	EXIT LOUVERS			
	ASSEMBLY:	Protractor	4012028-782	3.18
3.7	FRONT FRAME AND SCROLL			
	ASSEMBLY:	Lift Fixture	4012028-661	3.13
		Turnover Dolly	4012028-605	3.3
		Bearing Cage Support	4012028-790	3.19
		Spanner Wrench	4012028-615	3.7
		Tab Bender	4012028-618	3.10
	GRINDING:	Air Seal Grinding Fixture	4012028-678	3.16
	INSPECTION:	Seal Inspection Fixture	4012028-678	3.16
	TEARDOWN:	Lift Fixture	4012028-661	3.13
		Turnover Dolly	4012028-605	3.3
		Spanner Wrench	4012028-615	3.7
3.8	LIFT FAN			
	SHIPPING:	Dolly - Lift Fan	4012028-680	3.12
		Container - Lift Fan	4012028-619	3.11
3.9	REAR FRAME			
	ASSEMBLY:	Lift Fixture	4012028-661	3.13
	TEARDOWN:	Lift Fixture	4012028-661	3.13
		Template Exit Louver	4012153-941	3.20

FUNCTION	TOOL	NUMBER	FIGURE
3.10 ROTOR			
ASSEMBLY:	Support Stand	4012028-663	3,14
	Turnover Dolly	4012028-602	3.2
	Vertical Lift Fixture	4012028-613	3.5
BALANCE:	Balance Arbor	4012028-559	3.1
	Balance Stand	4012028-667	3.15
INSPECTION:	Inspection Stand	4012028-667	3.15
TEARDOWN:	Support Stand	4012028-663	3.14
	Turnover Dolly	4012028-602	3.2
	Vertical Lift Fixture	4012028-613	3.5
3.11 TURBINE BUCKET CARRIER SEGMENT			
ASSEMBLY:	Retaining Pin Inserting Tool	4012028-625*	3.17
TEARDOWN:	Retainer Pin Removal Tool	4012028-625*	3.17

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* NOTE: The retaining pin inserting and removal tool differs for right and left hand fans. The -625G1 tool is for a left hand unit, the -625G2 tool is for a right hand unit.

3.12 NUMERICAL TOOL LIST

NUMBER	NAME	REFERENCE PARAGRAPH
4012028-559	Rotor Balance Arbor	3.10
4012028-602	Rotor Assembly and Teardown Turnover Dolly	3.10
4012028-605	Front Frame and Scroll Assembly & Teardown Turnover Dolly	3.7
4012028-612	Ball Bearing Inner Race Puller	3.2
4012028-613	Rotor Assembly & Teardown Vertical Lift Fixture	3.10
4012028-614	Roller Bearing Inner Race Puller	3.4
4012028-615	Spanner Wrench, Front Frame & Assembly Bearing	3.7
4012028-616	Ball Bearing Outer Race Puller	3.3
4012028-617	Roller Bearing Outer Race Puller	3.5
4012028-618	Tab Bender, Front Frame & Bearing Assembly	3.7
4012028-619	Lift Fan Shipping Container	3.8
4012028-625	Turbine Bucket Carrier Retainer Pin Inserting and Removal Tool	3.11
4012028-661	Front Frame & Scroll Assembly & Teardown Lift Fixture	3.7
	Rear Frame Lift Fixture	3.8
4012028-663	Rotor Support Stand	3.10
4012028-667	Rotor Balance & Inspection Stand	3.10
4012028-678	Front Frame Air Seal Grinding & Inspection Fixture	3.7
4012028-680	Lift Fan Transportation Dolly	3.8
4012028-782	Exit Louver Protractor	3.6
4012028-790	Bearing Cage Support	3.7

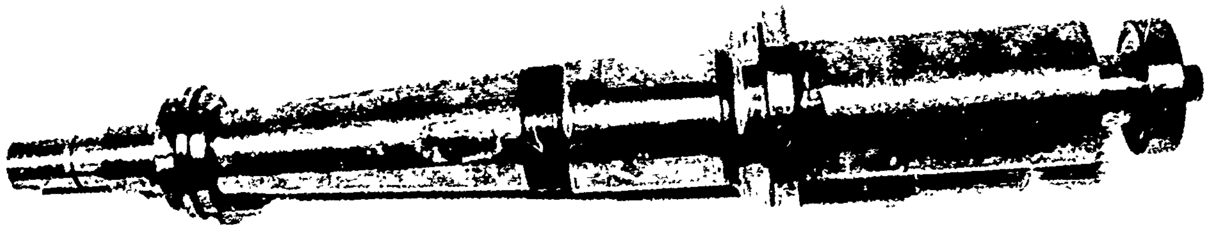


FIGURE 3.1 ROTOR BALANCE ARBOR

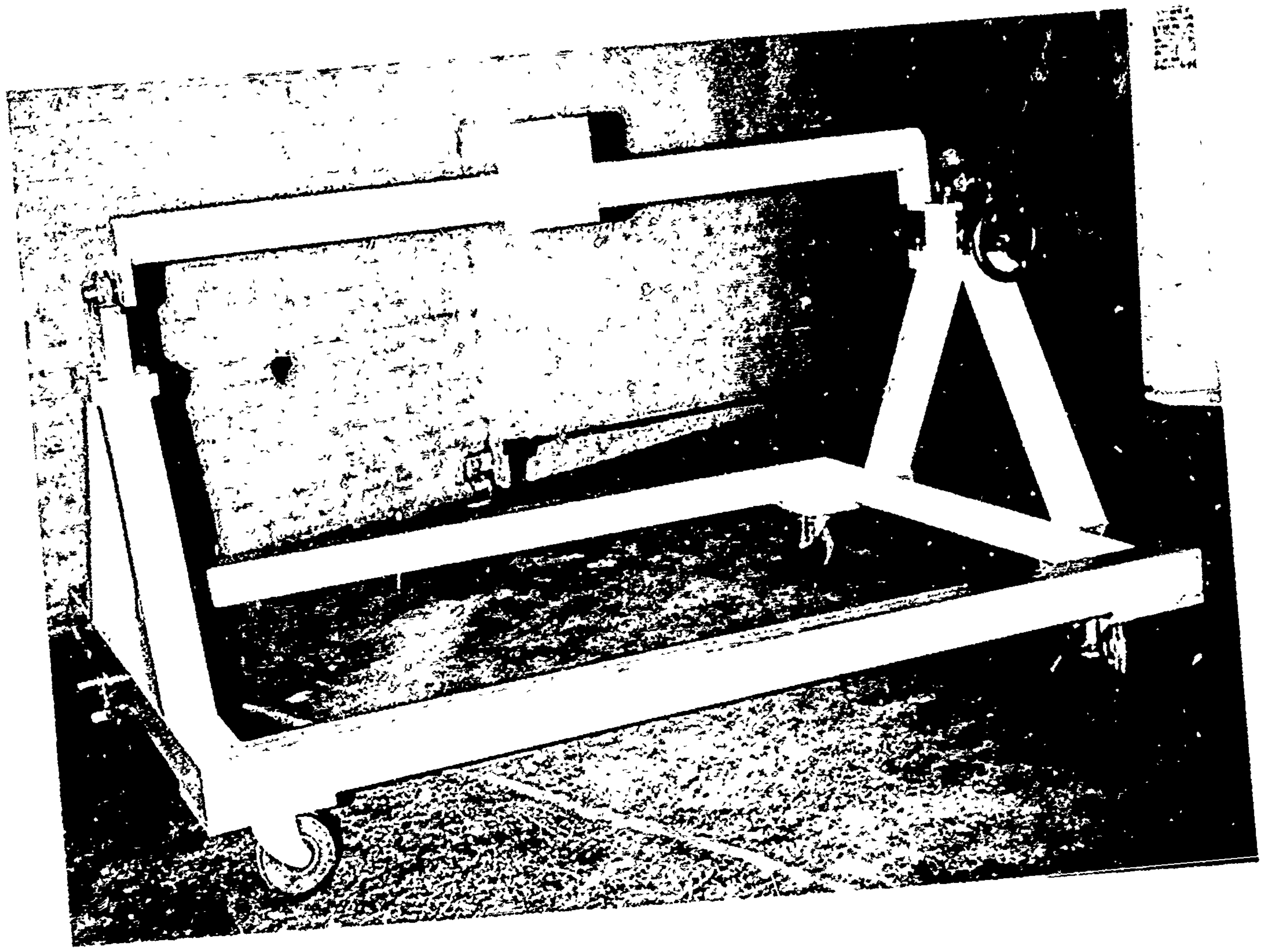


FIGURE 3.2 ROTOR TURNOVER DOLLY

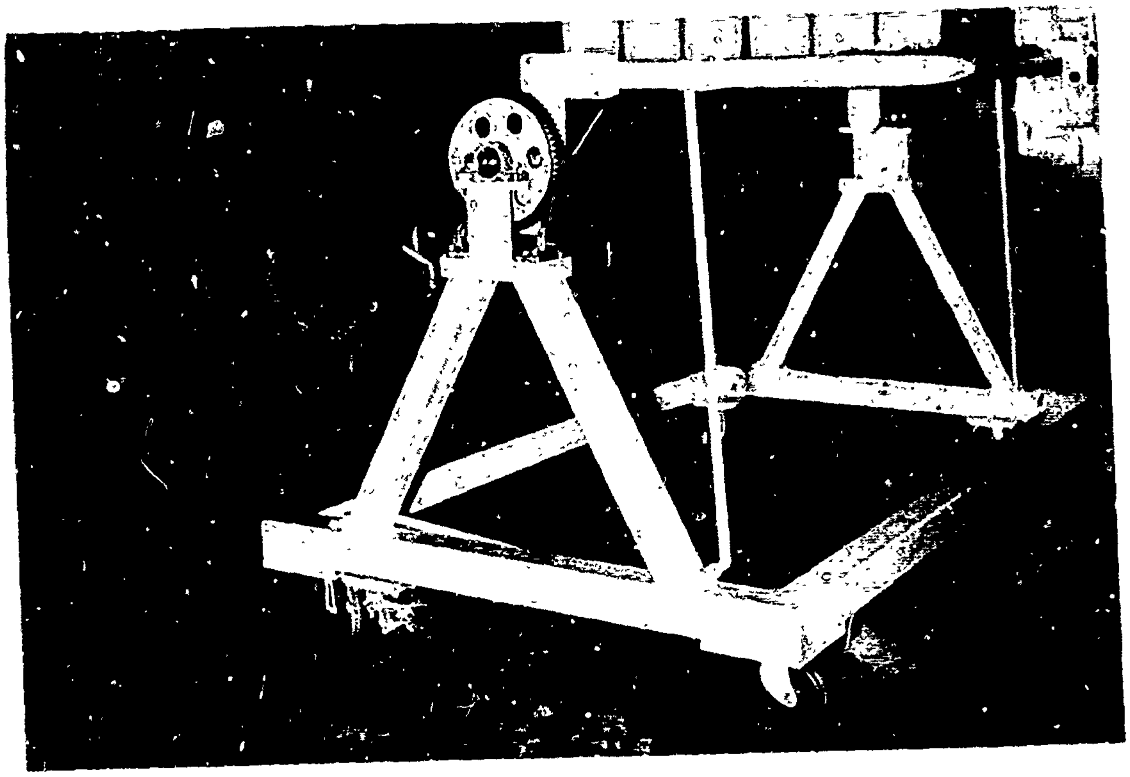


FIGURE 3.3 FRONT FRAME, SCROLL AND FAN TURNOVER DOLLY

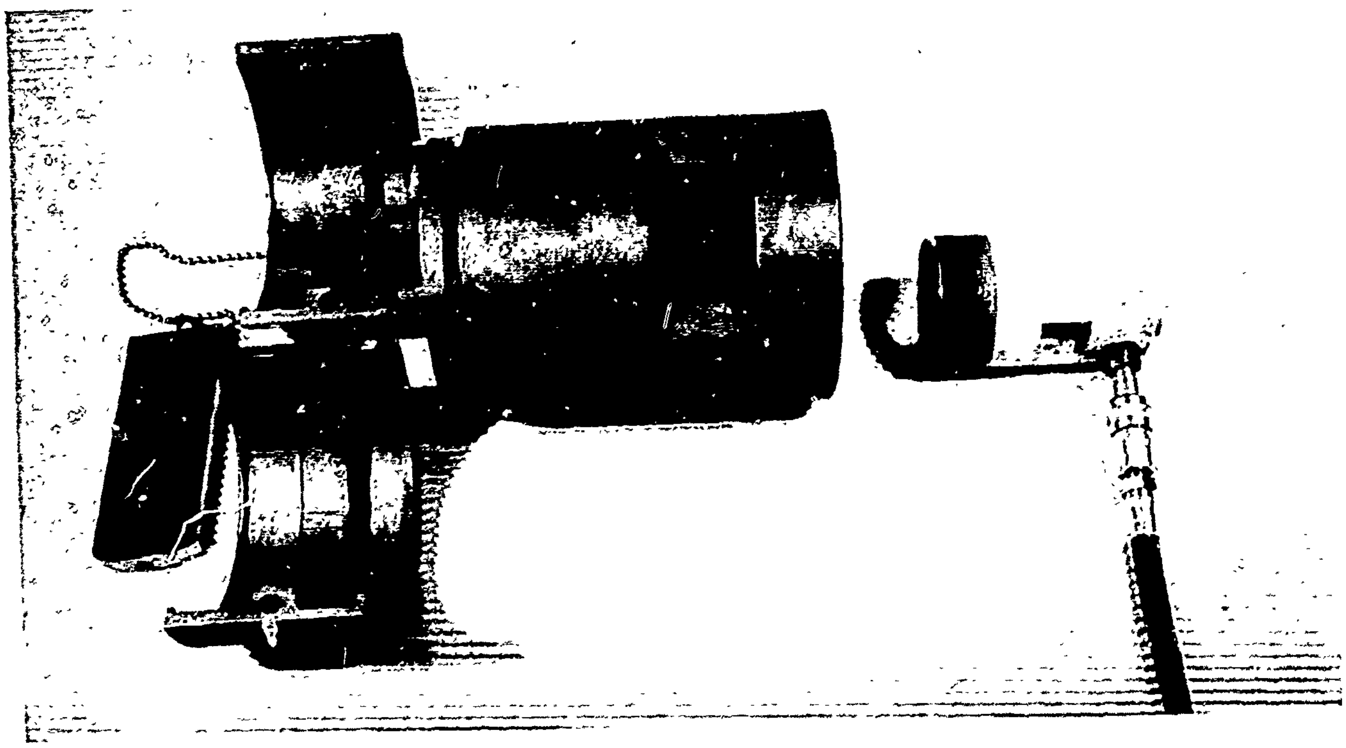


FIGURE 3.4 BALL BEARING INNER RACE PULLER

36

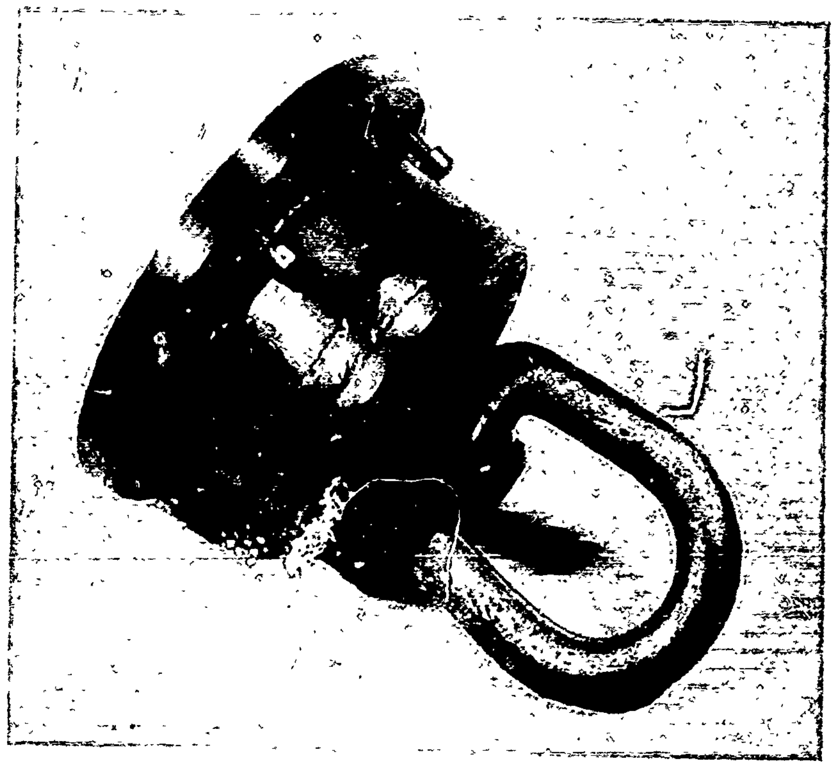


FIGURE 3.5 ROTOR VERTICAL LIFT FIXTURE

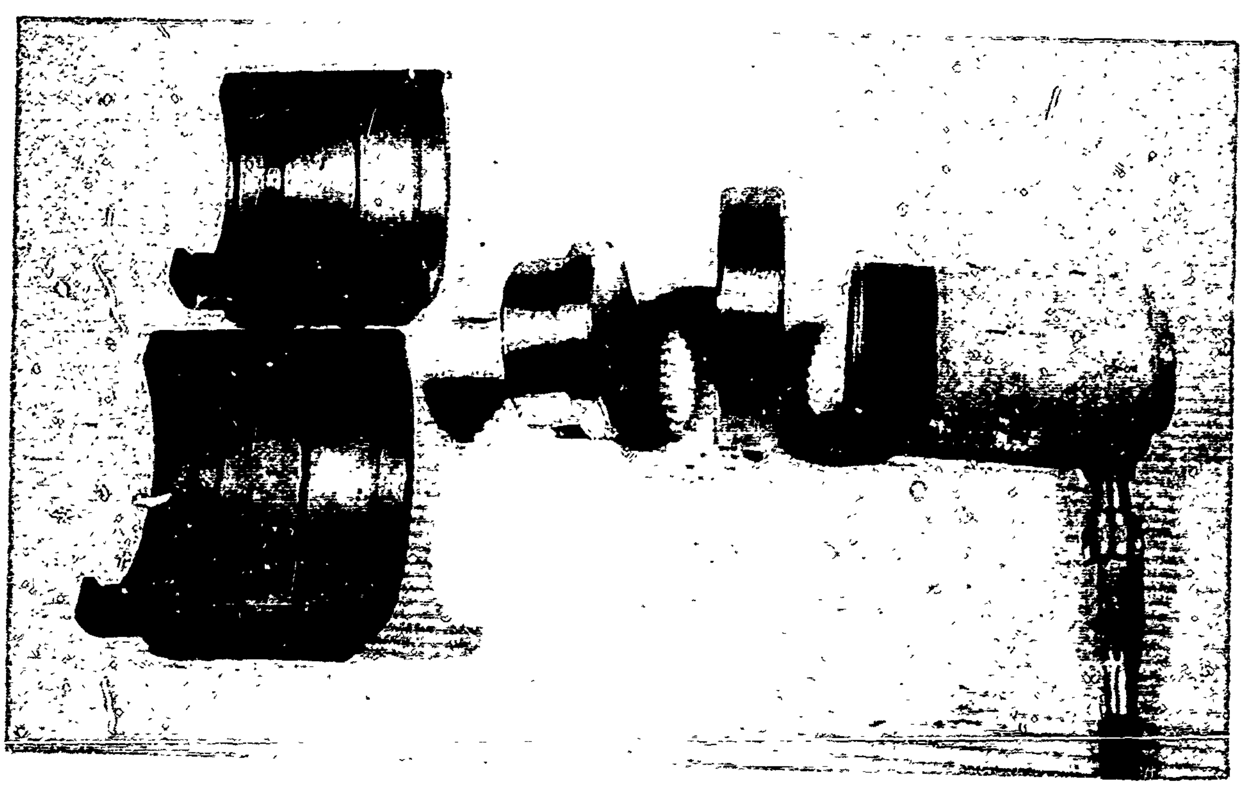


FIGURE 3.6 ROLLER BEARING INNER RACE PULLER

FIGURE 3.7 SPANNER WRENCH

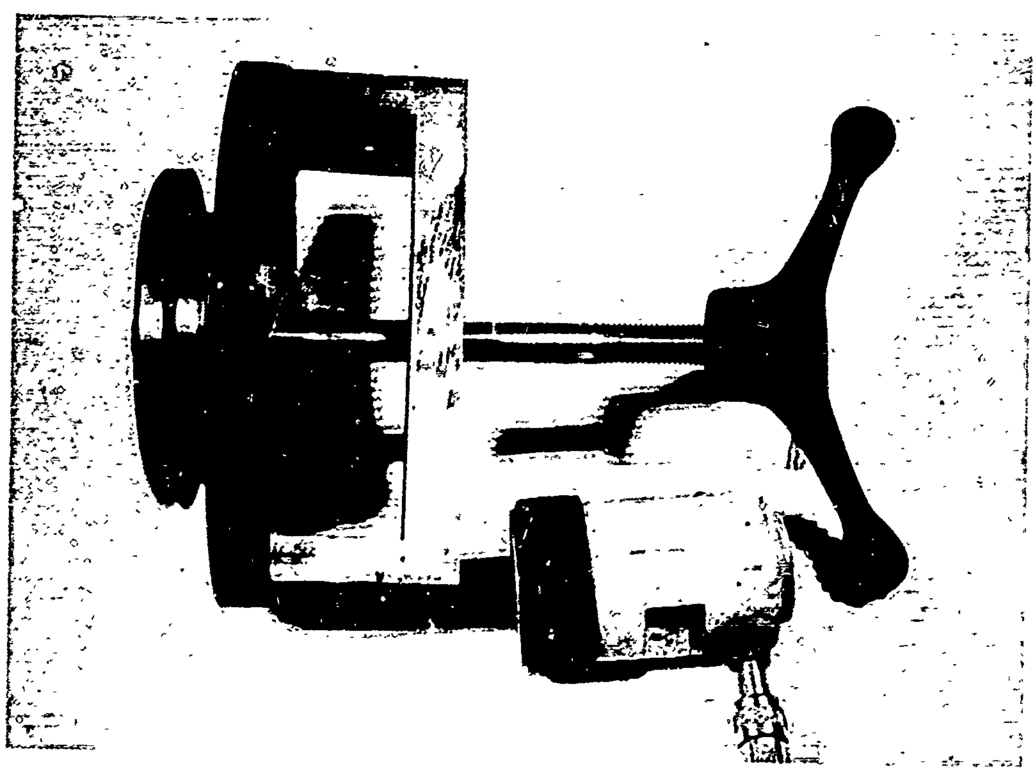


FIGURE 3.8 BALL BEARING OUTER RACE PULLER

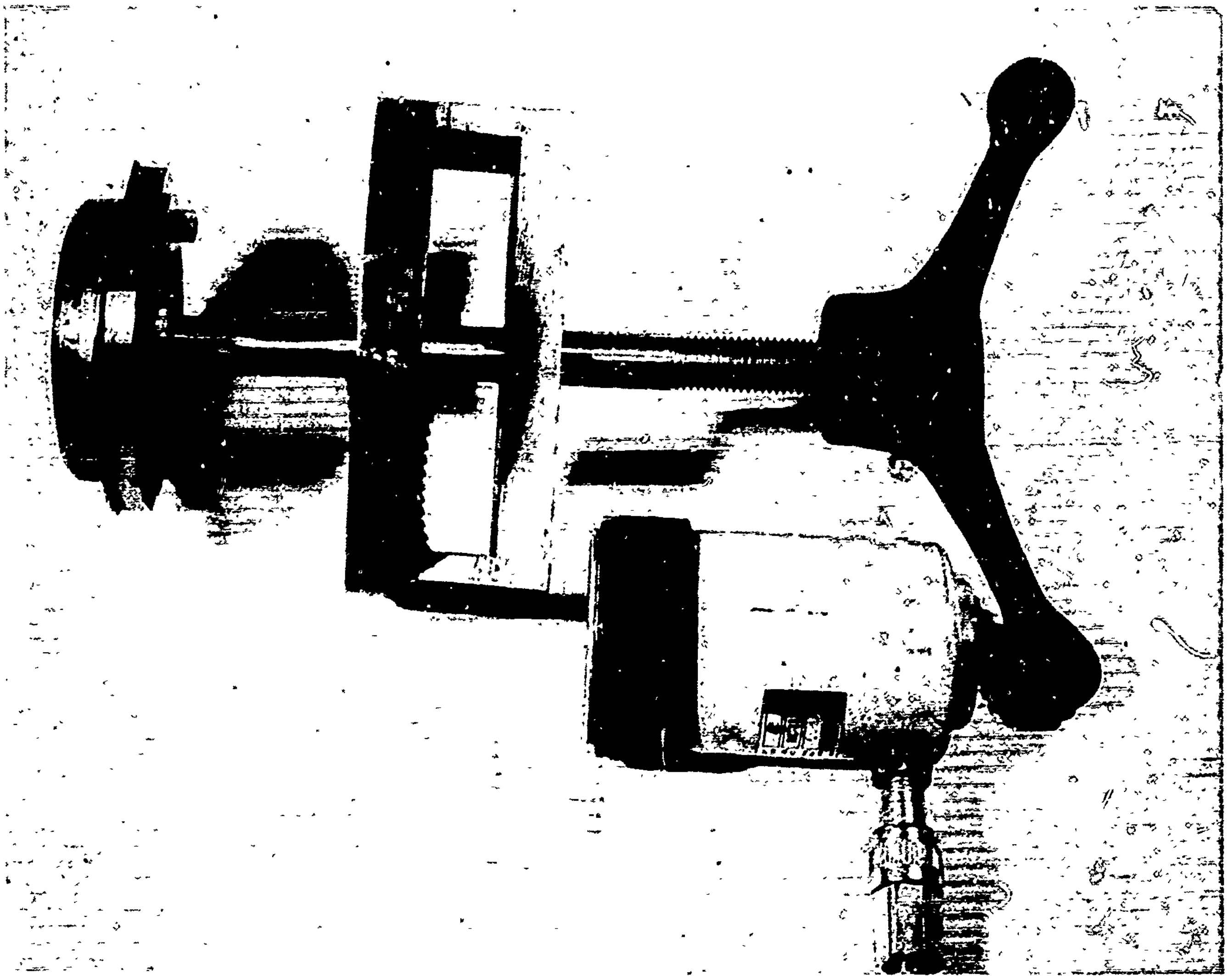


FIGURE 3.9 ROLLER BEARING OUTER RACE PULLER

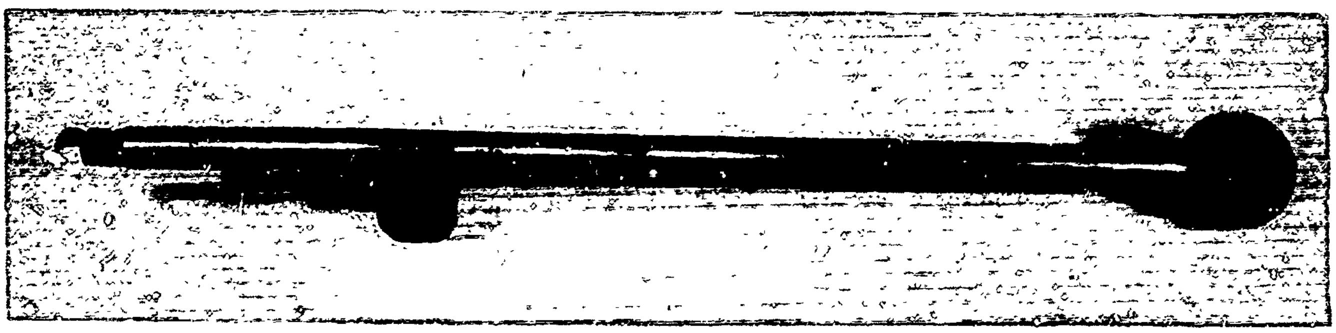


FIGURE 3.10 TAB BENDER, FRONT FRAME AND BEARING ASSEMBLY

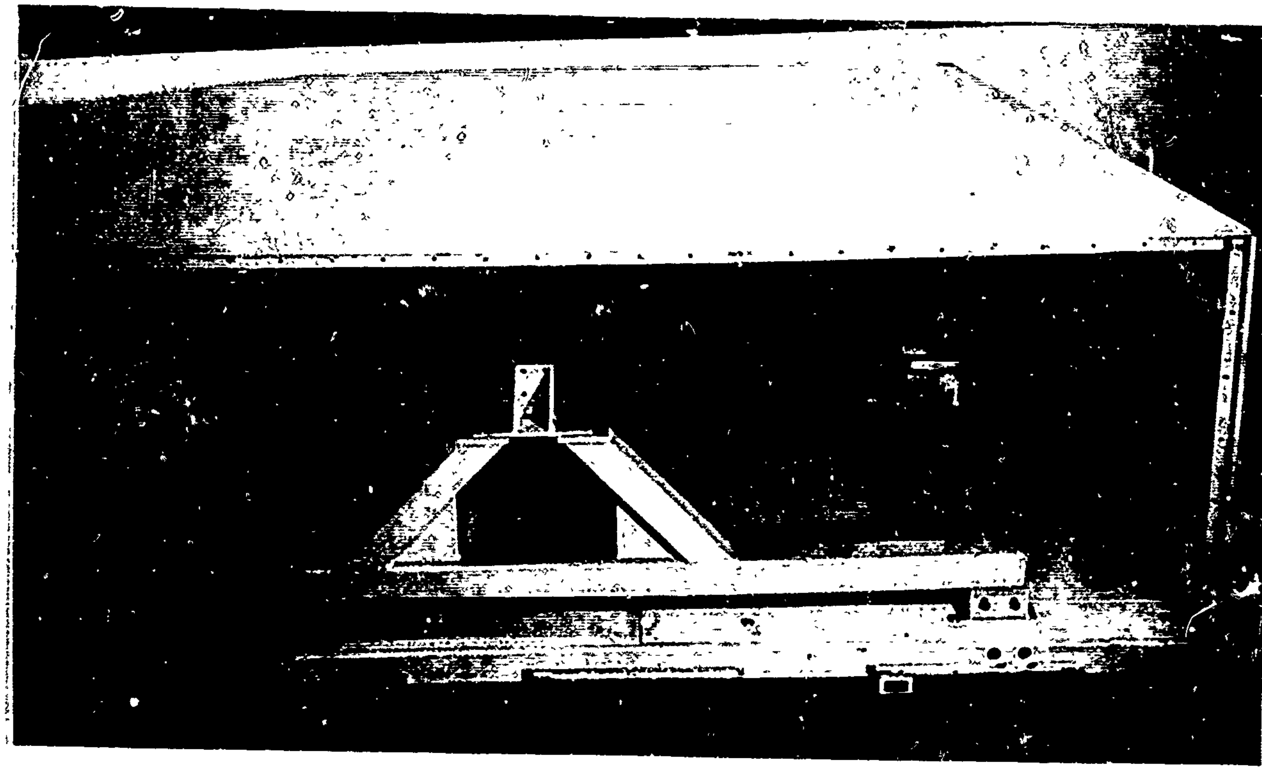


FIGURE 3.11 LIFT FAN SHIPPING CONTAINER

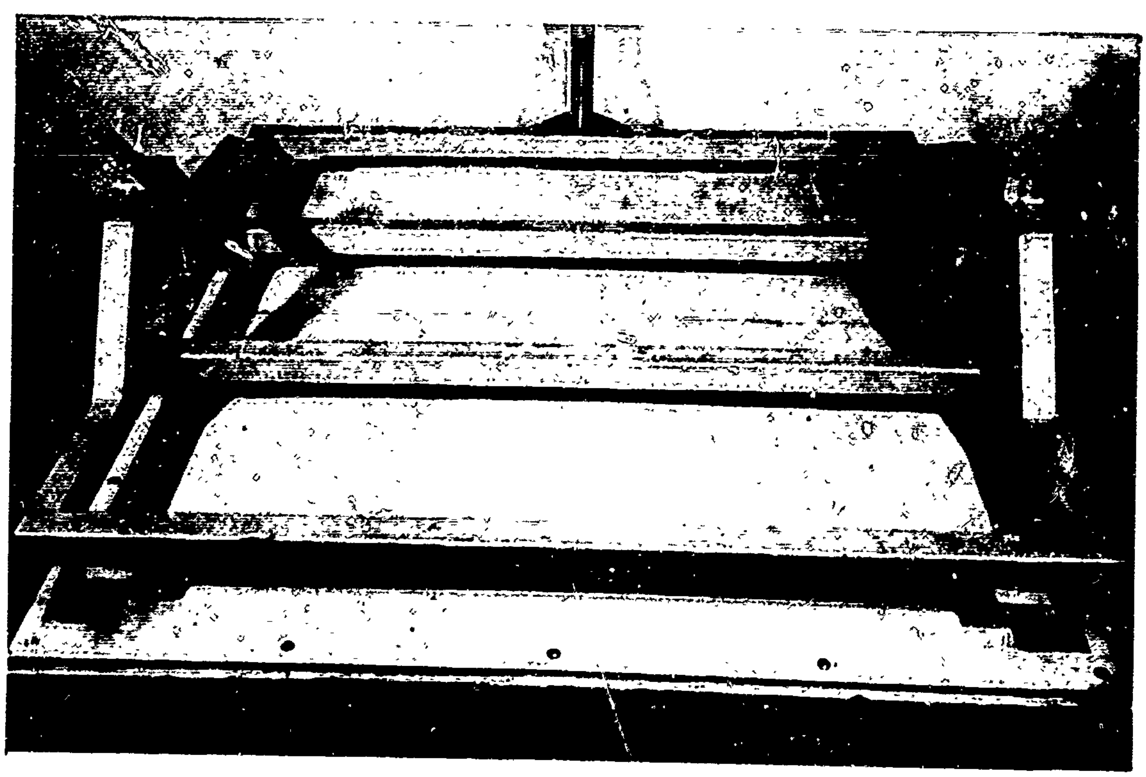


FIGURE 3.12 LIFT FAN TRANSPORTATION DOLLY

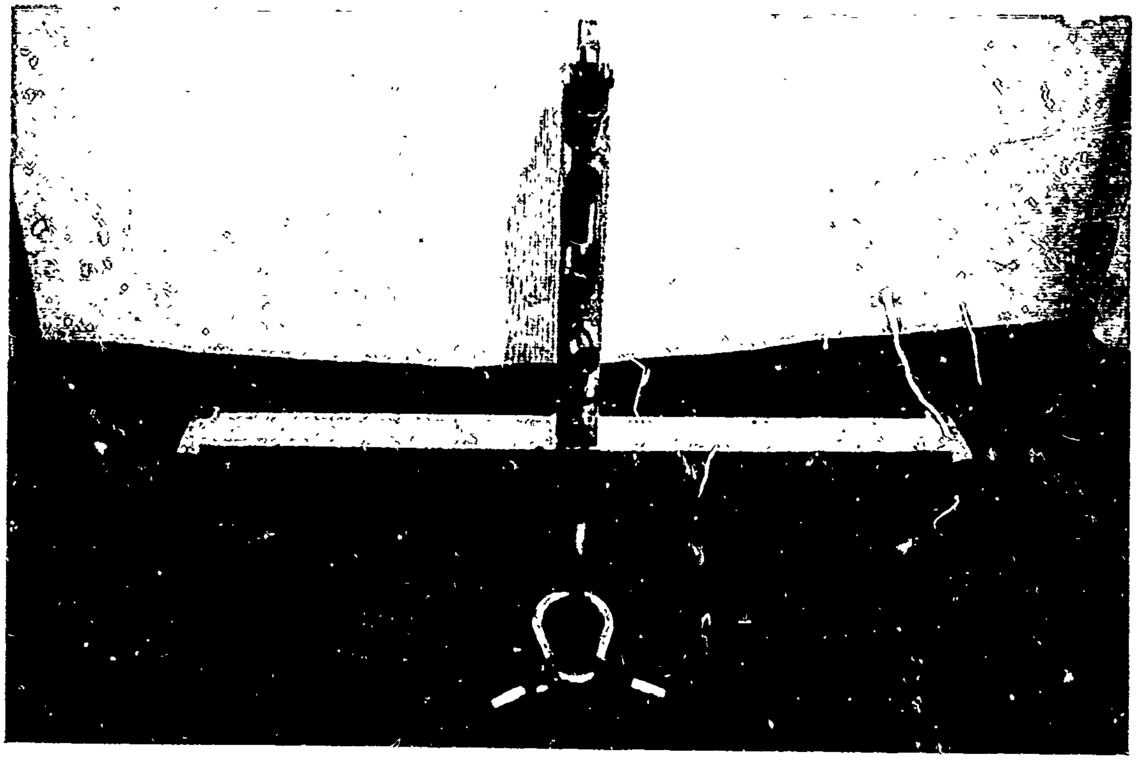


FIGURE 3.13 FRONT FRAME AND SCROLL LIFT FIXTURE

FIGURE 3.14 ROTOR SUPPORT STAND

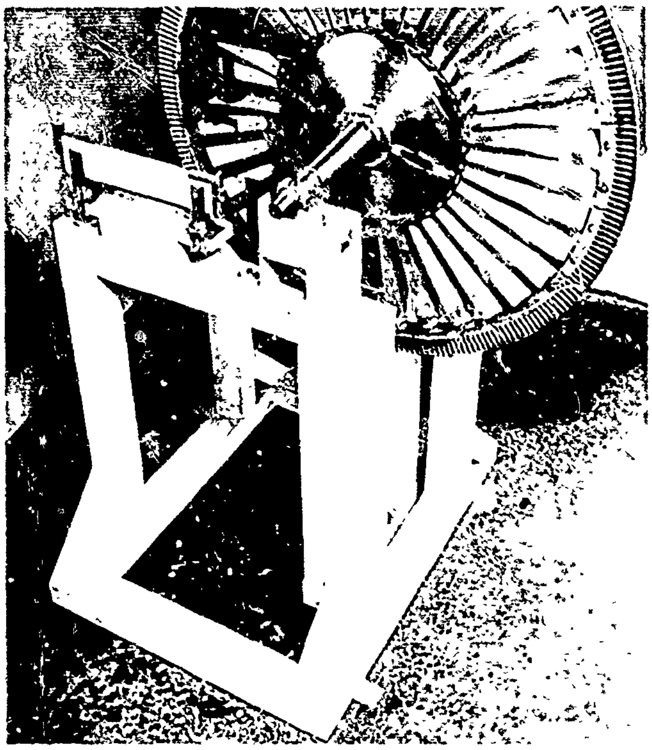


FIGURE 3.15 ROTOR BALANCE AND INSPECTION STAND

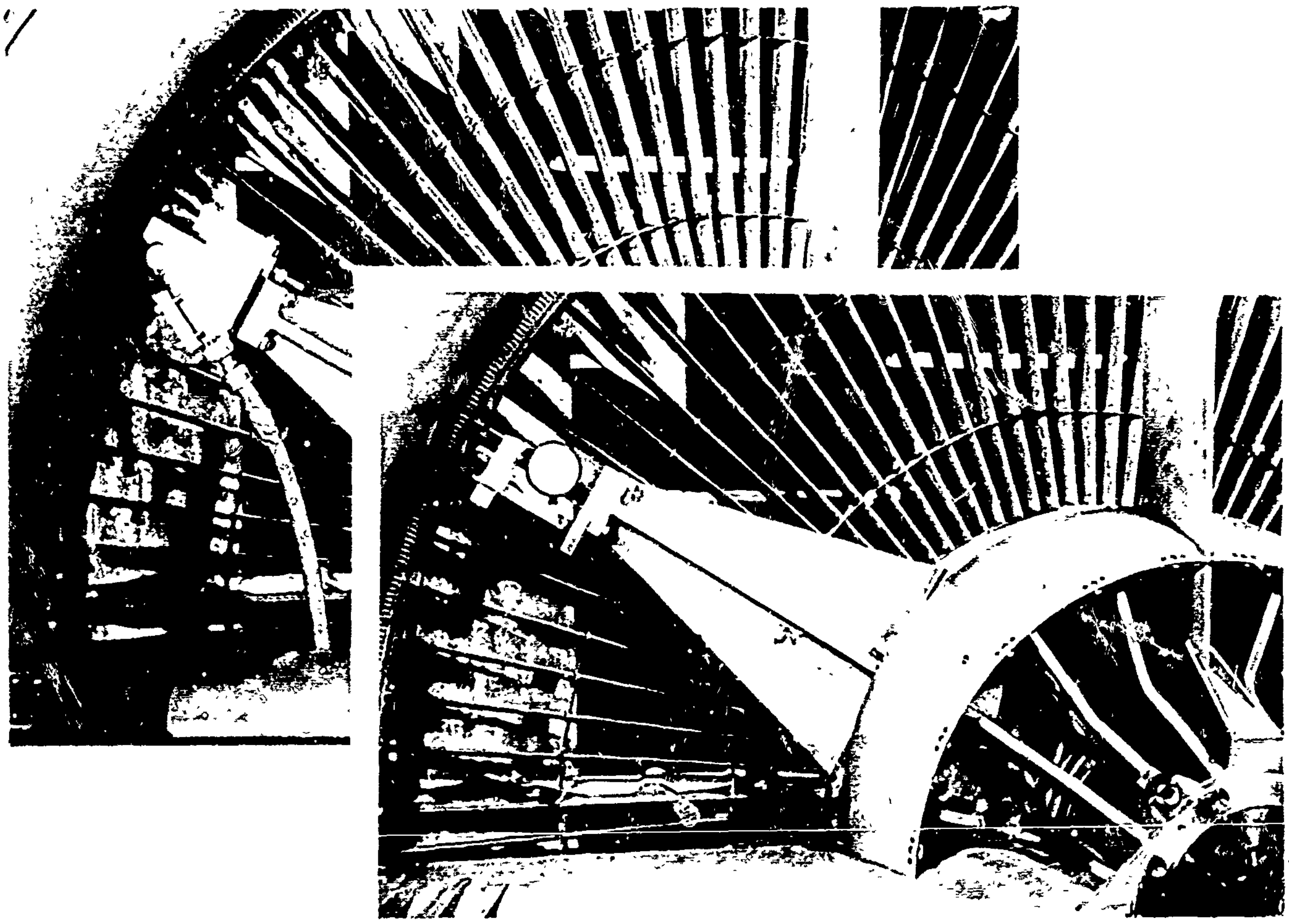
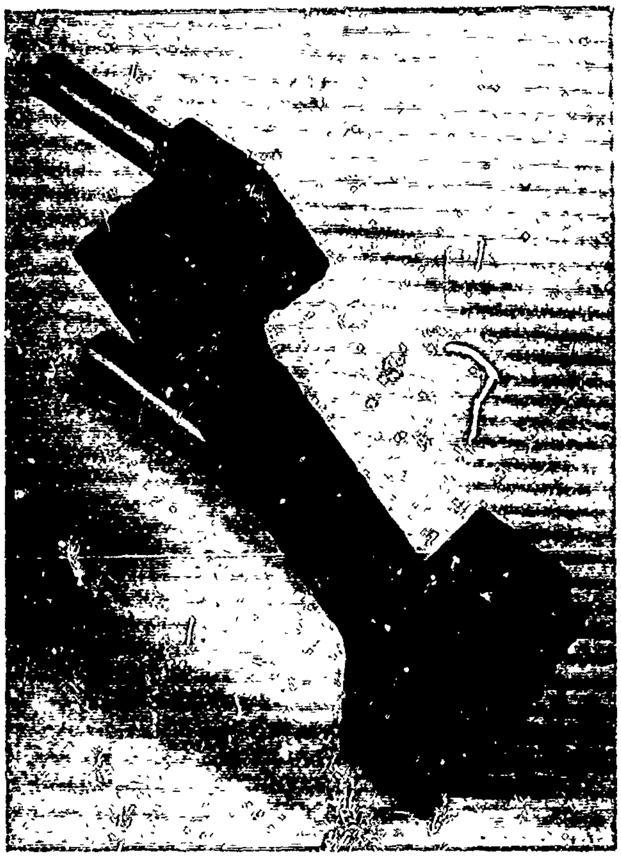


FIGURE 3.16 FRONT FRAME AIR SEAL GRINDING (LEFT) AND INSPECTION (RIGHT) FIXTURES



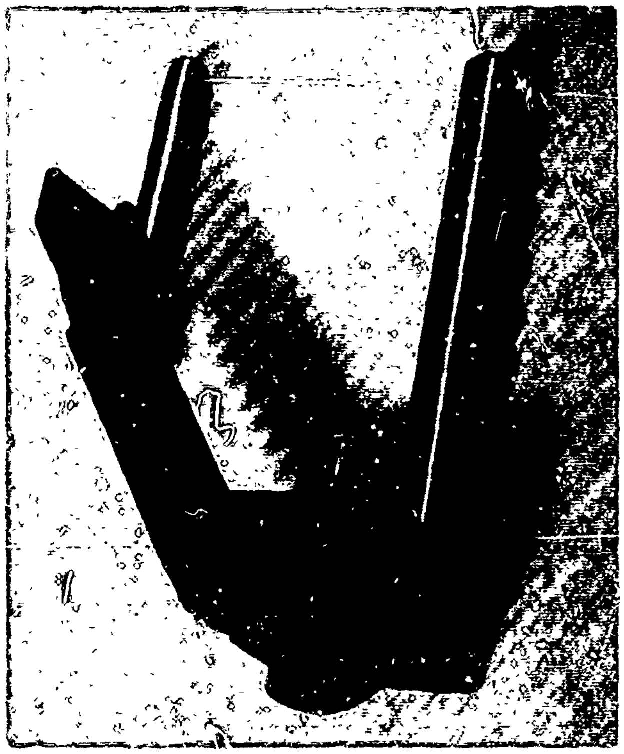


FIGURE 3.17 CARRIER RETAINING PIN INSERTING AND REMOVAL TOOL (TOOL FOR LEFT HAND CARRIERS ON LEFT; TOOL FOR RIGHT HAND CARRIERS ON RIGHT)

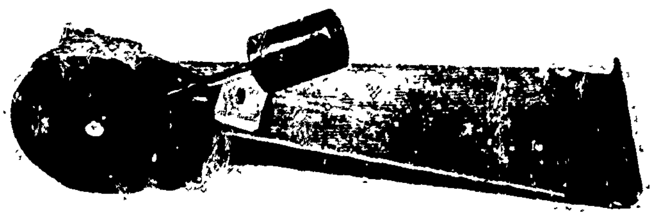


FIGURE 3.18 EXIT LOUVER PROTRACTOR

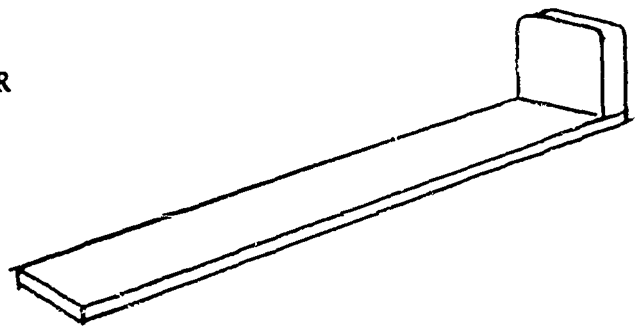


FIGURE 3.19 BEARING CAGE SUPPORT

FIGURE 3.20 EXIT LOUVER TEMPLATE

SECTION 4.

ASSEMBLY OF X353-5B

4.1 GENERAL ASSEMBLY PROCEDURE

4.2 Scope

This section presents instructions for assembly of the individual parts into sub-assemblies; assembly of these into components; and final assembly of the X353-5B system (Figure 4.1). The procedure presents the sequence of assembly and calls out the quantity of parts but does not list the part numbers.

When starting an assembly sequence, read and observe all NOTE and CAUTION remarks for that sequence.

4.3 ASSEMBLY TOOLING

Where an assembly tool is required, the name of the tool will appear in the sequence of use (in the Tooling Section of this manual).

4.4 ROTOR ASSEMBLY (REFERENCE FIGURE 4.2)

NOTE

Orientation shall be as follows: viewing the rotor from the top (forward side) looking down (toward the aft side), place the zero point (indicated by the serial number on the disc rim) at the 12 o'clock position. The #1 blade dovetail slot will be the first slot clockwise from the zero point. The #1 carrier seal will fit over the blades in the #1 and #2 slots. If the covers and platforms are position-marked, the #1 cover and platforms will be located between blade positions #1 and #36. The gaps between the forward torque band segments will be located at blade positions #1, 7, 13, 19, 25, and 31; the gaps between the aft torque band segments will be located at blade positions #4, 10, 16, 22, 28, and 34.

4.5 Disc and Shaft Assembly

Set the disc and shaft assembly on the rotor build-up platform with the long end of the shaft extending up. Assemble the forward retaining ring over the studs on the forward face of the disc. The upturned edges on the ring should face away from the disc. Assemble 36 nuts and tighten snug (torque will be accomplished after balance).

4.6 Install the disc and shaft assembly into the turn-over dolly using the rotor vertical lift fixture. Place the rotor in an attitude with the long end of the shaft pointing down.

4.7 Insert the blades into the dovetail slots from the aft side of the disc. The concave side of the blade should face up. The particular location of each blade should be listed by serial number on the Check List and Build-up Record (per Balance Calculation Procedure see Par. 4.13).

NOTE

Blade serial numbers will be etched on the bottom face of the blade root.

NOTE

Periodic Inspection: At the first teardown, or at any disassembly after the position of the blades has been established to be within acceptable balance limits, (Par. 4.13), the position of each blade should be etched on the end of the tang with an electric vibrator.

CAUTION

The blade and disc dovetails are coated with special anti-gall compounds. Check the integrity of the application prior to each final assembly to make sure the application is acceptable (Par. 7.9A, 7.9B).

NOTE

Blade dovetails and dovetail slots must be free of dirt and oil. Wipe both areas clean with a shop cloth and acetone before assembly.

CAUTION

Extreme care must be exercised when handling blades and bucket carr .ers to avoid any form of damage.

4.8 Assembly of Rear Blade Retainer Ring

Install the rear blade retainer ring over the studs on the aft face of the disc. The upturned edges of the retainer ring should face away from the disc. Replace the nuts and tighten snug. Final torque will be accomplished after balance.

NOTE

The retainer ring holes must fit around the shoulders on the disc studs. Tighten four bolts 90° apart and pull the ring over the shoulders before tightening the rest of the nuts. Make sure all areas of the retainer tabs are flush with the face of the disc.

4.9 Assembly of Blade Platforms

Insert the 36 blade platforms between the blades and secure them to the locknuts on the retainer ring tabs with two shoulder bolts to each platform. Tighten the nuts sufficiently to hold the parts; they will be torqued after balance.

4.10 Assembly of Torque Band Segments

a. Assemble six forward and six aft torque band segments to the rotor blade tips. Figure 4.19 specifies the position of each segment and locates the gaps between the segments. The torque band segments, carrier seals, and carrier segments are assembled at the same time and in accordance with Pars. 4.10, 4.11 and 4.12.

CAUTION

The gaps between the torque band segments must be located as positions specified in Figure 4.19. Forward and aft segments are identical and should be position-marked before disassembly.

4.11 Assembly of Carrier Seals

Assemble the 18 carrier seals over the blade tip tangs and seat them against the torque band per the Rotor Balance Record. The tabs on the torque bands containing grommets must be sprung inward to permit the carrier seals to pass over them. Align the carrier seals so that the grommets on the torque bands will seat in the hole in the center tab of the carrier seal.

NOTE

The side of the seal with the smallest tab faces forward. Avoid assembling the seals in reversed position (forward to aft), this will cause difficulty in assembling the last carrier.

4.12 Assembly of Bucket Carrier Segments

a. Assemble the 18 bucket carrier assemblies to the blade tip tangs, torque bands and carrier seals. The location of the carrier segments is determined from Balance Plots (See Balance Record). The grommets on the torque bands fit into countersunk holes on the inside rail of the carrier assembly. The tabs containing the grommets must be sprung inward to permit assembly of the carrier segment.

b. Determine the position of the first carrier segment. Slide it into position, use care to seat the torque band grommet in the countersunk hole on the inside rail of the carrier.

c. Insert the center carrier cover into the carrier segment and align the nut with the grommet in the torque band. Insert two bolts, one from each side, and tighten sufficiently to hold and locate the parts.

NOTE

The center cover appears identical to the end cover except that the center cover has two nuts while the end cover has four (the part numbers are also different). The cover containing two nuts is assembled to the center of the carrier segment.

d. Assembly of blade retainer pins, lock pins, and lock strips.

The blade retainer pins are supplied in five different diameters. The proper size pin for each location is determined by select fit during initial assembly of the rotor. When assembling new parts, use the following procedure to select the proper pin size. At each of the 36 pin locations, determine the largest pin diameter that will fit into the blade and carrier pin holes. The retainer pin should be worked into the hole by hand using the special tool provided (Par 3.11) until the pin is through the tang hole. For a proper fit, it will be necessary to tap the pin gently until it is in place using the pin installation tool. Align the lock pin hole before the retainer pin is driven into position.

NOTE

The pin holes in the blade tang and carrier have polished surfaces and must be clean for assembly.

f. Insert the pins from the end of the carrier toward the center of the carrier. Some twisting motion of the pin and some axial displacement of the carrier may be required to assemble the pins. If the pin works all the way in by twisting alone, remove it and try the next largest size.

NOTE

For ease of assembly and to eliminate binding, use a thin lubricating oil on the pin before assembly to the blade and carrier.

g. After the proper size pin is selected and installed, align the lock pin hole in the retainer pin with the hole in the carrier and carrier seal. Insert the lock strip between the carrier and the carrier seal; align the hole in the lock strip with the holes in the retainer pin, carrier and seal. Insert the lock pin and bend the lock strip over the lock pin head.

4.13 ROTOR BALANCING

List the rotor blades in a column in order of decreasing moment weights. Divide the list into pairs and determine the difference in moment weights of the blades in each pair; ie., 1 and 2, 3 and 4, 35 and 36. List these differences in an adjoining column. Lay out the blades on a balance plot (Figure 4.0) by placing the blades of a pair opposite each other beginning with blades 1 and 2 in blade positions 1 and 19; and alternately selecting pairs of blades from the top and bottom of the list; ie., blades 36 and 35 in blade positions 2 and 20. The blade plot should be filled out in this manner. Differences in blade moment weights should be determined for opposite carriage position. A judicious relocation of blades may have to be made to minimize these differences. Any relocation of blades should be made by pairs. Instrumented blades should be placed at least 90° apart.

Carriers and seals should be listed as described above for the blades. The balance plot for the carriers should be made as described for the blades. Differences in blade moment weights for opposite carrier positions should be placed on the plot and a judicious relocation of carriers should be made so that pairs of carriers with a large difference in moment weights are placed so as to balance blades with a large difference in moment weights. This procedure should also be followed for the seals.

Assemble the balance arbor to the rotor and balance the rotor on knife edges. Add balance weights equally to the forward and aft sides of the rotor until no unbalance is indicated. If an odd number of weights is required, add the extra weight to the aft side of the rotor. The maximum correction weight is 150 grams or 5 balance weights.

NOTE

Enter the amount and location of weights added to the rotor on the Balance Record Form.

4.14 TORQUING PROCEDURE

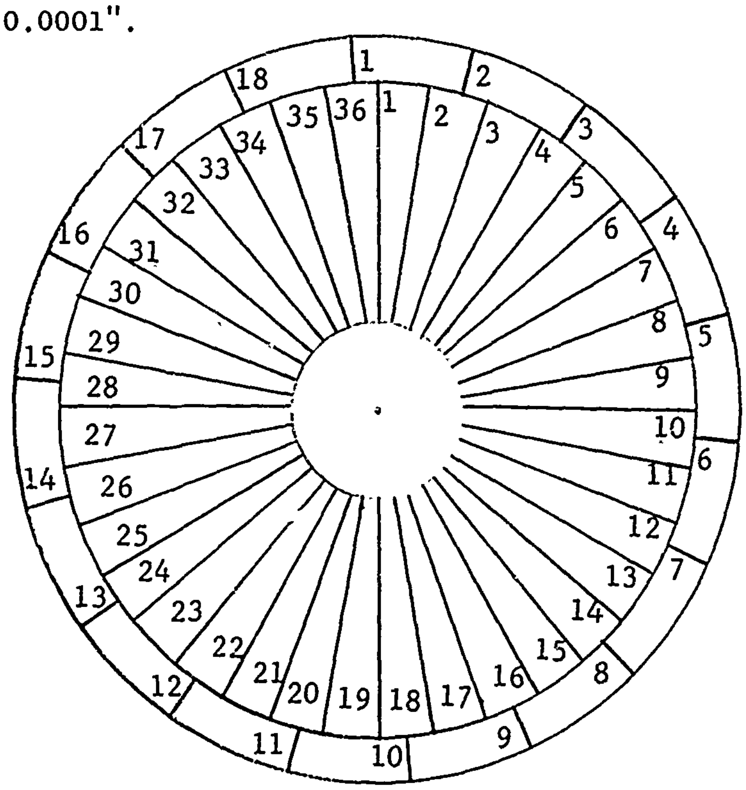
a. Torque all nuts and bolts on the rotor assembly using the following torquing procedures:

b. Rotor Tie Bolts

1. Tooling Requirements

a) Two torque wrenches (0 to 400 lb. in. gage) with 7/16" 12 point sockets.

b) One 3-to-4" OD micrometer having increments to 0.0001".



Balance Plot - Top Looking Down

Figure 4.0

2) Loosen all nuts and measure and record (on Figure 4.3) the free state length of each rotor tie bolt (36).

3) Starting at the 0 (or 12 o'clock) position and proceeding in a clockwise direction, complete the following torquing procedure for each rotor tie bolt.

4) Torque the nut on the forward face at 100 lb. in.

5) Torque the nut on the aft face to 200 lb. in.

6) Torque the nut on the forward face to 300 lb. in. or until the stud elongates 0.006" ± 0.0005", whichever comes first.

7) If necessary, torque the nut on the aft face to 300 lb. in. or until the stud elongates 0.006" ± 0.0005", whichever comes first.

8) If at this point, the stud has not elongated 0.006", alternately tighten the nuts on the forward and aft faces to 350 lb. in. or until the stud elongates 0.006" ± 0.0005", whichever comes first.

9) Record the final length of each tie bolt and the torque value for both the forward and aft nuts on Figure 4.3.

NOTE

When torquing the rotor tie bolts, use torque wrenches, one on the forward side and one on the aft side.

c. Blade Platform Shoulder Bolts

1) Torque blade platform-retainer ring shoulder bolts on both sides of the rotor to 35 lb. in.

d. Carrier Tab and Carrier Seal Shoulder Bolts

1) Torque the carrier tab and carrier seal shoulder bolts according to the instructions and torque values presented in Figure 4.19 (refer to Figure 4.2).

4.15 ROTOR RADIAL INSPECTION

a. Measure and record on Figure 4.4 the maximum running radius of the top and bottom air seal lip and the turbine bucket shroud.

b. Measure and record on Figure 4.4 the F.I.R., maximum radius and mark the location of the maximum radius with Dykem.

c. Record inspection results on Figure 4.4.

4.16 FRONT FRAME ASSEMBLY

a. Assemble the front frame into the buildup dolly.

4.17 ORIENTATION

a. For orientation of the front frame refer to Par. 2.3, General Description.

NOTE

All front frames are interchangeable and can be assembled either as right hand or left hand units.

4.18 ASSEMBLE INSULATION BLANKET

a. Lay the insulation blanket in place on the frame and align the inner and outer bolt circles with those in the frame. Insert the bolts from the blanket side and install a nut on the outside. Torque the nuts to 27 to 30 lb. in. Install the two radial bolts and nuts and torque to 27 to 30 lb. in. Stretch the bottom flange of the blanket over the aft flange of the front frame and, using nichrome strips, tweezer-weld the blanket to the front frame per Figure 4.5.

NOTE

All holes should line up and the ID of the blanket should be flush with the bellmouth before tightening the nuts.

NOTE

Do not assemble the bolts to the inner and outer bolt circles. However, bolt circles in the insulation blanket and the front frame should be aligned.

b. Inspection and Adjustment

During initial assembly and after each removal of the blanket from the front frame, the radial runout of the ID of the blanket must be checked and recorded on Figure 4.5. This dimension is required to assure clearance between the rotor shroud and insulation blanket.

NOTE

Do not remove the insulation blanket for normal periodic inspection.

4.19 ASSEMBLY OF 81° SCROLL MOUNTS

a. The 81° scroll mount clevises are located at the 12:00 o'clock and 6:00 o'clock positions. Both parts appear identical. However, they are not symmetrical and must be located in one position only. The correct position is determined by a hole located in the support gusset. The plain end of the clevis faces the scroll center mount.

b. The clevis is shimmed as required and is attached with four bolts.

NOTE

For adjustment and location of the scroll to the front frame, refer to Inspection and Adjustment Section Par 4.21.

c. Periodic Inspection

During periodic inspection or teardown, do not remove the 81° clevises unless malfunction or fatigue is in evidence. If the clevises are removed, the re-assembly of these parts must be in accordance with the above note.

4.20 SCROLL ASSEMBLY

a. Set the scroll on a table with the mounts facing up.

b. Assemble the forward 81° mount using shims as required or provided and four bolts.

NOTE

The forward and aft 81° mounts are not interchangeable.

c. Assemble the aft 81° mount using shims as required or provided and four bolts.

d. Assemble the center scroll mount with four bolts.

e. Assemble a uniball bearing and snap ring to each of the three scroll mounts.

NOTE

The uniball and snap ring can be assembled to the scroll mounts prior to assembling the mounts to the scroll.

NOTE

During teardown, the uniball can work out of the housing if the center pin is not in place. To avoid this possibility, wrap masking tape around the mount and uniball.

NOTE

The uniball must be frozen in dry ice prior to assembly to the scroll mount.

CAUTION

The scroll center mount uniball has shims welded to each side of the bearing. The shims are welded in place after trial assembly to locate the scroll radially in the front frame. The thickness of the shim may not be the same for both sides. If the uniball is removed, care must be taken not to reverse its position during reassembly. If the uniball is replaced, comply with Par 4.21 in the Inspection and Adjustment of the Scroll to Front Frame.

f. Periodic Inspection

On normal periodic inspection, do not remove the three scroll mounts from the scroll unless there is indication of a malfunction or fatigue. The uniball bearings can be replaced with the mounts in position. If the mounts are removed, re-assemble per Par 4.21 in the Inspection and Adjustment Section.

4.21 Inspection and Adjustment of the Scroll to the Front Frame

a. To locate the scroll in relation to the front frame, the following areas must be considered:

1) Radial distance from the nozzle to the rotor vertical center line. (Dim. A, Figure 4.6)

2) Axial distance from the nozzle lips to the rotor horizontal center line. (Dim. B & C, Figure 4.6)

3) Location of inlet ducts with respect to 3, 6 and 9 o'clock mounts. (Figure 4.7)

4) Radial and axial location of scroll inlet flanges. (Figure 4.7)

b. The sequence of adjustment should be as follows:

1) Adjust the radial distance from the rotor centerline by adding shims to the inboard or center mount.

a) Determine and record on Figure 4.8, the width of the uniball slot in the front frame scroll support and the width of the uniball inner race.

b) Compute the total shim requirement by subtracting the width of the uniball from the width of the slot.

c) To obtain the initial base to set the radial location of the scroll, divide the shim requirement by two. This determines the width of the shim to be added to each side of the uniball.

d) Tack weld one shim of proper thickness to each end of the uniball inner race. Use heli-arc weld with 0.032" 321 stainless steel wire. Use minimum amount of weld to hold the shim in place.

NOTE

The clearance between the overall length of the shimmed uniball and the overall width of the slot should be 0.005" to 0.010".

2) Center the ends of the scroll radially from the rotor centerline and add shims under the end clevises on the front frame.

3) Raise or lower the scroll axially by adding or removing shims under the scroll mounts.

4.22 Assembly of Scroll Finger Seals

a. The seals must be trimmed and fitted to eliminate holes or leakage areas at the ends and corners and to form a continuous seal surface around the nozzle diaphragm. Proper overlap must also be provided for the overlapping seals on the front frame and rear frame. The scroll and both frames must be trial assembled so that a line may be scribed on the finger seals to determine the actual overlap. The finger seals should be assembled between the frame seals so that the scroll will expand from the center mount out along the pin in the 81° mounts. Required overlap is:

1) Minimum overlap is 3/16" from the edge of the seal lip.

2) Maximum overlap is full use of the immersion depth.

b. After the overlap lines are scribed, remove the scroll and trim the finger seals to obtain overlap as indicated in Figure 4.9:

1) Obtain maximum overlap at the ID, and

2) Minimum overlap at the OD and at the ends.

c. Matchmark position of finger seals - After trial assembly and custom fitting is complete, position mark the finger seals as follows: The seals will be numbered 1 through 30 starting from the end of the scroll and working around in the direction of gas flow from the nozzle. Etch the number on the visible nozzle side of the seal with an electric vibrator.

d. Periodic Inspection - Removal of the scroll finger seals is not required for periodic inspection except in case of malfunction or indication of fatigue. If the seals must be removed, check first to be sure they are match marked. If they are not marked, refer to Par 4.22c and mark per procedure prior to dis-assembly.

e. Re-assembly of Scroll Finger Seals

NOTE

The seals are custom fitted and should be position-marked. Re-assemble per indicated position number (refer to Par 4.22c).

1) Slide the outside seal segment over the bead on the OD of the nozzle per position number.

2) Slide the inner seal segments over the bead on the ID of the nozzle per position number.

3) Slide the end seal segment over each end per position number.

f. Replacement of Scroll Finger Seals - Refer to Par 4.22a.

4.23 Assembly of Scroll Insulation

a. Assemble the scroll insulation blanket and lockwire the sections to each other and to the scroll.

4.24 Final Assembly of Scroll to Front Frame

a. Place the scroll in position on the front frame and insert the pin and snap ring into the center mount. Insert the 81° mount pins at both ends of the scroll and assemble the nut to each pin. Torque the nut to 100 lbs. in.

4.25 Assemble Scroll Seals and Air Seal Supports

a. The top and bottom scroll seals are sandwiched between the front frame flange and the air seal support. Lay the top and bottom seals in place over and under the scroll finger seals. Hold in place temporarily until the seal support segments are in place.

b. Place the seal support segments over the scroll seal segments and insert a bolt and tighten.

c. The seal support segments which are assembled over the insulation blanket side are installed in the same fashion. Torque center bolts to 35 lb. in., end bolts to 25 lb. in.

4.26 Assemble Honeycomb Air Seal

a. The honeycomb air seal is attached to the front frame air seal support with #10-32 bolts. The end of each spacer is attached per Figure 4.10. Torque the center bolt in each segment to 35 lb. in. Torque the end bolt in each segment to 25 lb. in.

b. After initial assembly, the honeycomb air seal must be ground to a dimension which is obtained as follows: Determine the maximum radius of the top air seal (dimension A from Figure 4.4, Rotor Inspection) and record this dimension on Figure 4.11. To this dimension, add 0.075" - 0.095" (provides air seal clearance) to obtain the desired radius of the honeycomb air seal. Grind the seal to this radius using the grinding fixture (Ref. Par. 3.7). After grind, inspect and record (on Figure 4.11) the radius of the honeycomb seal. Mark the location of minimum radius with Dykem.

c. Periodic Inspection - Do not remove the seals or scroll from the front frame for a normal periodic inspection. All areas are visible for inspection. If the seals must be removed, their position must be marked prior to disassembly. Upon reassembly, the radial runout of the seal must be checked to assure proper rotor clearance before the rotor is assembled.

4.27 Assembly of Thrust Bearing Outer Race

a. Place the forward (or top) grease shield in the groove in the thrust bearing housing located in the forward frame.

b. Freeze the outer race and assemble it into the housing. Insert the balls and cage into the outer race.

c. Assemble the thrust bearing grease seal into the retainer.

d. Assemble the retainer ring using twelve (12) #10-32 bolts and nuts. Torque to 35 lb. in.

e. Slide the magnetic speed support bushing into the sump support boss from the center of the sump and align the anti-torque pin in the boss groove. Secure with a nut from the outside of the sump wall torque nut to 25 in. lb. and lockwire.

4.28 Assemble Rear Frame Insulation Blankets

a. Place the rear frame radial blanket into the frame and insert the radial bolts th[illegible]h from the inside of the frame and attach a nut and washer. (Reference Figure 4.12)

NOTE

The flange hole in the blanket must line up with the flange bolt holes.

b. Pull the blanket out radially against the rear frame flange and tweezer weld a strip of nichrome to the flange and blanket to hold the blanket in place until the rear frame is assembled to the unit.

c. Place the bottom blanket into the rear frame pan and bolt it to the rear frame. The bolt head will be located in the blanket with the nut on the outside of the frame.

NOTE

Torque all bolts to 35 lb. in.

d. During initial assembly and after each removal of the blanket from the rear frame, the radial runout of the blanket must be checked and recorded on Figure 4.13. This dimension is required to assure clearance between the rotor shroud and insulation blanket. To perform this inspection, assemble the rear frame to the unit and sweep the inside diameter of the blanket using the inspection tool.

4.29 Assembly of Rear Frame Air Seal Segments

a. Place the rear frame honeycomb air seals in the rear frame and assemble the bolts. Torque to 30-35 lbs. in. and lockwire as follows:

1) On the long seal segments lockwire the center bolt to the adjacent gusset.

2) Lockwire the end bolts to each other across the saw cut.

NOTE

The rear frame seal segments are provided in two different lengths. These should be assembled so that the seals do not span the sawcuts in the rear frame box section.

b. After initial assembly, the honeycomb air seal must be ground to a dimension which is obtained as follows: Determine the maximum radius of the bottom air seal (Dimension B from Figure 4.4, Rotor Inspection) and record this dimension on Figure 4.11. To this dimension, add 0.140" to 0.150" (provides air seal clearances) to obtain the desired radius of the honeycomb seal. Grind the seal to this radius using the grinding fixture (Ref. Par 3.9). After grinding, inspect and record on Figure 4.11 the radius of the honeycomb seal. Mark the location of minimum radius with Dykem.

4.30 Assemble Rotor to Front Frame and Scroll

a. Assembly of the rotor to the front frame and scroll initiates the second phase of final assembly. The procedures outlined in Par. 4.1 through 4.29 must be completed prior to starting this phase of assembly.

4.31 Assemble Bearing Inner Races to Rotor Shaft

a. Heat the ball and roller bearing inner races to a maximum temperature of 250°F.

b. Assemble the shim and bottom (aft) half of the ball thrust bearing inner race to the shaft.

NOTE

Position the inner race so that the puller notch is toward the shim.

c. Insert the two halves of the roller bearing retainer into the groove at the end of the shaft. Slide the roller bearing inner race over the shaft using a shim of the same thickness as that used on the ball thrust bearing. After the race is seated, bend the retainer ring tabs out radially into the groove in the end of the inner race. If the tabs are too long, trim them to fit the groove.

NOTE

Position the beveled end of the roller bearing inner race toward the end of the shaft.

4.32 Assemble the Rotor to the Thrust Bearing

a. Pack the thrust bearing balls and cage with 60 grams of sodium soap base lubricant (Texaco Unitemp-500 or equivalent).

b. Attach the rotor lift fixture and raise the rotor to a position with the shaft end pointing down.

CAUTION

The magnetic speed sensor must not be installed during assembly of the rotor to the front frame. Serious damage to the front frame could result.

c. Lower the rotor shaft into the front frame and seat the inner race gently until the weight of the rotor is supported by the bearing.

NOTE

The thrust bearing cage must be held in place until the bearing seats in the outer race, Figure 3.19.

d. Place the heated inner race into the race puller and seat the race in position on the shaft. Hold the race in position until the temperature of the shaft and race equalize and the position is maintained by the interference fit. The race should become tight in about 10 to 20 seconds.

e. Slide the tab washers in place.

f. Assemble the retaining nut and torque to 275 to 300 ft. lbs. Bend the washer tabs into position. The remaining tabs must be bent up to clear the rotor speed sensor (see Figure 4.14).

CAUTION

Bend the tab all the way into the slot. Be certain the tab is below the level of the slot so it will not interfere with the speed pick-up sensor.

4.33 Assemble the Roller Bearing

a. Assemble a metal grease shield, a Teflon grease shield, then a second metal grease shield into the groove in the roller bearing housing.

b. Freeze with dry ice and push the outer race and rollers into the roller bearing housing.

c. Freeze with dry ice and insert the grease seal into the retainer..

d. Assemble the retainer using twelve bolts. Torque the bolts to 30 lb. in. and secure with lockwire.

e. Pack the roller bearing with 40 grams of sodium-soap base lubricant (Texaco Unitemp-500 or equivalent).

f. Slide the bearing assembly over the end of the shaft and seat the outer flange on the front frame. Install eight bolts and nuts and torque to 35 lb. in.

g. Drop Check Axial Clearance of Bearing - to assure that the thrust bearing inner races are seated, measure the distance from the end of the rotor shaft to the forward face of the roller bearing housing (take measurement with long end of shaft pointing down). Invert the entire rotor assembly to the flight attitude (long end of shaft pointing up) and take the same measurement. The difference between the two readings should be less than 0.036". If the clearance is within limits (less than 0.036"), return the unit to the inverted flight position (shaft pointed down).

CAUTION

If the clearance of the thrust bearing (measured in Par. 4.33g) exceeds 0.036", the cause must be determined and corrected before proceeding with assembly of the unit. Serious damage can result from excessive thrust bearing clearance.

h. Measure the axial distance between the thrust bearing inner race and the bottom face of the thrust bearing housing. The minimum gap in the inverted position is 0.090". (Ref. Figure 4.16B, Dim. #1)

4.34 Clearance Inspection Prior to Assembly of Rear Frame

a. Measure and record (per Figure 4.16C) with rotor in inverted position, items 10, 9, 8, and 5.

b. Record the readings and compare with drawing tolerances. If any dimension falls outside the drawing tolerances indicated on Figure 4.16C, shim the rotor to bring the dimensions within limits.

CAUTION

If shims are added to bring rotor clearances within limits, take care to maintain the minimum clearance between the roller bearing inner race and the housing (Ref. Dim. #1, Fig. 4.16B). The minimum clearance is critical and must be maintained.

4.35 Assembly of Rear Frame to Front Frame

a. Assemble the top and bottom outer scroll seals to the scroll finger seals.

b. Hoist the rear frame using the T-bar lift fixture with Nylon slings and position it over the front frame, rotor and scroll assembly. Lower the rear frame and guide it carefully over the rotor until the flange meets the scroll seal studs.

NOTE

Make sure the rear frame flange is circumferentially lined up with the front frame flange.

c. Align the rear frame with the scroll seal studs and lower the frame until it is seated. Insert 46 bolts on the "cold side" of the rear frame flange. Apply a high temperature lubricant to the bolts and install 90 nuts around the complete flange. Torque the nuts and bolts to 50-60 lb. in.

d. Assemble six rear-frame-to-scroll turnbuckles and adjust them to line up with the rear frame and scroll. Tighten the jam nuts on the turnbuckles and install lockwire. Insert 12 pins and lock them in position with 12 snap rings.

NOTE

The two pins that fit in the two center scroll supports are slightly longer than the pins which are assembled to the other 10 scroll supports.

e. Assemble the scroll insulation blanket and lockwire them in place.

f. Assemble the insulation blanket around the "hot side" of the rear frame and lockwire it in place.

4.36 Clearance Inspection after Assembly of Rear Frame

a. Visually check the overlap of the scroll finger seal to make sure it did not slip out of place during assembly of the rear frame.

b. Measure and record (on Figure 4.16B) clearances #1, 2, and 4. Make sure the shim thickness (Dim. #3 in Figure 4.16B) is recorded along with the amount of bearing axial travel.

c. Measure and record (on Figure 4.16C) clearances #5, 6, 7, 8, 11, 12, 13, and 14.

NOTE

When checking items #7, 10, 11, and 14 above, align the Dykem marks which indicate the high and low radius of the various parts. When checking the other items, make a full sweep of the circumference of the mating parts.

4.37 Assemble and Adjust Magnetic Spee. Pickup

a. Slide the magnetic speed sensor into the support bushing using shims to obtain a gap of 0.030"/0.020" between the magnetic element and the rotating speed generator on the rotor shaft. Tighten the nut to 25 in. lb. and lockwire.

CAUTION

During assembly, the magnetic speed pickup must not be installed until the inspections in Par. 4.36a through 4.36c are completed and indicate the rotor will remain assembled. Serious damage can result if the magnetic speed pickup is in place during assembly or disassembly of the rotor to the front frame. Upon disassembly, the magnetic speed pickup must be removed before the rotor is removed from the front frame.

4.38 Setting of Nozzle Area Adjustment Vanes

a. At initial assembly, set the nozzle area adjustment vanes in the scroll assembly to the full open position. The position of these vanes will be readjusted after initial test of the lift fan.

4.39 EXIT LOUVER ASSEMBLY

a. The exit louvers can be assembled to the rear frame at any point of assembly of the lift fan. They can be removed and replaced as a set or as individual units. Removal and replacement can be carried out on the aircraft without removing the lift fan assembly from the aircraft.

b. This procedure will cover the assembly of the exit louvers without regard to the attitude or location of the rear frame. Refer to Figure 4.12 for assembly drawing of the rear frame and exit louvers.

4.40 Orientation of the Exit Louver Push Rods

a. The exit louver assembly has two push rods housed inside the rear frame strut that actuates and controls the position of alternate gangs of louvers. This alternate actuation of exit louvers provides spoiling of the fan thrust to give the aircraft roll and yaw control and to provide thrust vectoring for forward thrust. One push rod is actuated from the forward on the 12 o'clock position of the strut and is designated the forward push rod. Likewise the push rod that is actuated from the aft or 6 o'clock position is designated the aft push rod.

b. In the aft end of the strut the push rods have built-in stops to limit the travel of the louvers to prevent tip clash during high stagger or spoiling and also in the opposite direction to prevent negative spoiling.

c. A cam link is attached to the rear frame rear actuation bracket which pivots with the aft push rod and is followed by a roller located in the aft end of the forward push rod.

d. The full operating band for differential vectoring and spoiling is shown in Figure 4.23

4.41 Assembly of Exit Louver Push Rods

a. Assemble seven lever arms to the forward push rod with the flat head pins and fasten with cotter pins. The head of the pin is located on the inside side of the push rod. The spline shoulder should face in the direction of the pin head.

b. Assemble the slave link to the cam end of the push rod and insert the pin through the push rod with the pin head in the side containing the recess. Lock the pin with a snap ring.

c. Assemble the lever arms to the aft push rod in the same fashion described above.

NOTE

All moving surfaces of the exit louver system should be coated with a high temperature lubricant.

d. Lay both push rods side by side, position the cam and insert both rods into the strut. Locate and insert the slave link on the 6 o'clock end of the strut and fasten it with a snap ring. Align the lever arms with the ports in the side of the strut and insert a spline bushing into each lever arm.

4.42 Assemble Louver Port Bushing to Strut

a. Freeze the louver port bushings and insert them into the strut ports. The bushings should have a slight interference fit with the holes in the strut.

4.43 Assemble Bushings to Supports

a. Assemble all bushings to the outer louver supports using the special pressing tool.

4.44 Assemble the Lever Arms to Louvers

a. Assemble a lever arm to each louver using the adjusting bolt (per Figure 4.17).

4.45 Assemble Exit Louver #14

a. This louver must be assembled first to coordinate the louver travel with that of the push rod. The following step-by-step procedure must be followed (refer to Figure 4.12 for station numbers):

1) Set the aft push rod in the full closed position using Template 4012153-941P (57.25 Deg. cam link angle full closed).

2) Slide the louver assembly (#14) over the spline and into the bushing with the louver trailing edge smooth to the bottom wing fairing (or approximately 1/4" from touching the rear frame). Slide the end louver support bracket over the end of the louver and attach with 2 bolts.

NOTE

Axial adjustment of the exit louvers - if the gap between the lever arm and the end of the louver at the pivot pin exceeds .030" when the lever arm bolt is tight, remove the lever arm and place washers over the pivot pin to eliminate this gap. This is to restrict the axial movement of the spline. The gap between the support and the end of the louver must not exceed .030". If this gap exceeds .030" insert washers in this area to remove gap. This gap permits the louver to slide axially away from the struts with possible spline disengagement.

4.46 Assemble Louver #13

a. Slide #13 louver over the spline and into the bushing in the full-closed position with the trailing edge resting on louver #14.

4.47 Assemble Remaining Louvers

a. Continue assembling the aluminum louvers as louvers #13 and #14 in the closed position.

4.48 Assemble Turbine Louvers - #3 thru #12

a. Insert a torque transmission plug into the end of the compressor louver. Slide the turbine louver slot over the plug and fit the pivot pin into the support bushing. Assemble the support bushing to the turbine louver and attach with two bolts.

4.49 Inspection of Louver Stagger

a. To insure that the exit louver trailing edges do not interfere during combined vector and full stagger, the following check is required.

b. With the exit louvers in the full-closed position and the aft cam link set at 57.25°, operate the aft push rod through its full travel to full open with the forward push rod always in the full-aft position against the stagger cam. The louver trailing edges should have at least 1/16" clearance through the full operating range. If interference does exist, adjust the forward louver sligntly open. Do not open gap by adjusting the aft louver in the closed direction.

4.50 ASSEMBLY OF CIRCULAR VANE

a. The circular vane is manufactured as a set of four quadrants. The manner in which the quadrants are assembled to the front frame determines whether the frame assembly is a right or left configuration. This is accomplished by shifting the circular vane 180° spanwise. When the quadrants are shifted 180° to form a left front frame, four new holes must be located and drilled in the front frame bullet nose.

b. The circular vane quadrant can be assembled to the front frame, removed and replaced at any point during assembly of the lift fan.

c. Assemble a floating pin to the bottom hole in the end of each cross vane and tighten. Place each quadrant into the frame and insert the floating pin end into the bottom holes located in the bullet nose. Secure each end pad to the strut using 2 bolts. Torque to 45-60 lb. in. and lockwire. Insert the 2 top bolts through the bullet nose into the top hole in the cross vane ends. Torque to 40-50 lb. in. and lockwire to the floating pin head. Insert the center circular vane support pin and shim on either side for height. Insert the vertical support bolt from the top and secure with the nut in the bottom. Torque to 25-30 lb. in.

CAUTION

The vane quadrant must not be forced to fit the frame in a restrained condition. The bullet nose holes and the major strut tang hole are custom located for the original vane quadrant that was installed. Removal and reinstallation of the same vane quadrant should cause no problem. If a new quadrant replaces the original quadrant relocation of the holes may be required to insure a proper fit.

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-941G1	Assembly - Left	X
2	4012001-190G2	Rotor Assembly	1
3	4012001-183G1	Slip Ring Assembly	1
	4012001-178G1	Adapter	1
	4012001-179P1	Key	1
	4012001-180P1	Retainer	1
	4012001-181P1	Key	8
	4012001-182P1	Connector	1
	5000-212W	Snap Ring	1
	5000-387W	Snap Ring	1
	4012001-230P1	Ring Retaining	1
4	MS24678-21	Bolt, Internal Wrench	4
5	4012001-300G2	Front Frame	1
	LHSS-6	Bearing	2
	ZL2440-11-048	Nut - Shank	8
	ZL2440-10-02	Nut - Shank	48
	ZL2440-5-048	Nut - Shank	16
	ZL3850-8-064	Nut - Shank	4
	ZA21-1200-02	Nut - Anchor	20
	70ZAIW-02	Nut - Anchor	4
	AN435M3-5	Rivet	8
	CR-562-4-4	Rivet	48
	4012001-302	Instrumentation	--
	4012001-301	Bellmouth Contour	--

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
5	AN124972	Rivet	40
	AN427M3-5	Rivet	148
	MF1000-3	Nut - Anchor	74
6	4012001-170P2	Bolt	48
7	4012001-306G1	Seal Corner	1
	4012001-327P1	Bolt	1
8	4012001-307G1	Seal Corner	1
9	4012001-308G1	Seal Corner	1
	4012001-327P1	Bolt	1
10	4012001-309G1	Seal Corner	1
11	4012001-310G1	Seal Sector	21
	4012001-327P1	Bolt	42
12	4012001-311G1	Seal Sector	21
13	4012001-312G1	Seal Corner	1
14	4012001-313G1	Seal Corner	1
15	4012001-314G1	Seal Corner	1
16	4012001-315G1	Seal Corner	1
17	4012001-316G1	Seal Sector	11
18	4012001-317G1	Seal Sector	11
19	4012001-405G2	Vane - Quadrant	1
20	4012001-405G3	Vane - Quadrant	1
21	4012001-405G4	Vane - Quadrant	1
22	4012001-405G5	Vane - Quadrant	1
	4012001-417P1	Pad	2

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
22	4012001-417P2	Pad	2
	MS51975-16	Bolt	4
	59FAF-518	Nut	4
	RRN-68	Snap Ring	4
	LHSSVV-4	Bearing	4
	4012001-429P1	Pad	2
	R105P2SL	Bolt	8
	4012001-430P1	Retainer - Bearing	4
	LHSS-5	Bearing	4
	4012001-432P1	Washer	AR
	R398P1	Nut	4
	4012001-431P1,P2 or P3	Spacer	AR
	4012001-429P2	Pad	2
23	4012001-322P2	Bearing - Roller	1
24	4012001-323P2	Bearing - Ball	1
25	4012001-324P1	Seal - Grease	1
26	4012001-324P2	Seal - Grease	1
27	4012001-325P1	Shield - Grease	2
28	4012001-326P1	Retainer - Seal	1
29	4012001-330G1	Housing - Bearing	1
	AN122683	Dowel Pin	1
30	4012001-331G1	Seal - Compressor	23
31	4012001-332G1	Support - Seal	24
	Z2440-3-02	Nut - Shank	24

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
32	4012001-337G1	Blanket - Insulation	1
33	4012001-340P1	Retainer - Seal	1
34	4012001-342P1-P5	Shim	AR
35	4012001-343P1	Shield - Grease	1
36	4012001-345P1 or P2	Shim - Bearing	AR
37	4012001-346P1 or P2	Shim - Bearing	AR
38	4012001-348P1 or P2	Spacer	AR
39	4012001-351P1	Clevis	2
40	4012001-352P1	Bolt	2
41	4012001-362P1	Bolt	48
42	4012001-363P1	Shield - Grease	1
43	4012001-364P1	Washer	24
44	4012001-365G1	Bushing	1
45	4012001-366P1	Nut	1
46	4012001-367P1	Nut - Spanner	1
47	4012001-368P1	Washer - Tab	1
48	4012001-370P1	Retainer - Bearing	2
49	4012001-371P3	Pickup - RPM	1
50	4012001-372P1	Spacer	AR
51	4012153-117P2	Bolt	8
52	4012153-250P1	Bolt	4
53	4012001-347P1	Pin	1
54	AN104608	Bolt	66
55	AN509C10-9	Screw	16

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
56	R113P14UL	Bolt	8
57	R106P4SL	Bolt	16
58	4012001-619P2	Pin	4
59	AN960C10L	Washer	26
60	MS2033-2	Bolt	8
61	MS20500-1032	Nut	8
62	MS9034-12	Bolt	98
63	MS9200-07	Nut	1
64	MS9088-08	Bolt	12
65	MS9088-12	Bolt	8
66	1803-02	Nut	46
67	Z1835-054	Nut	2
68	Z1855-048	Nut	90
69	N5000-62	Snap Ring	1
70	4012001-640G1	Rear Frame - Left Assembly	1
71	4012001-450G4	Scroll - Left	1
	4012001-453P1	Vane - Splitter	8
	4012001-454P1	Vane - Splitter	5
	4012001-456P1	Strut	15
	4012001-457P1	Nozzle Partition	30
	4012001-457P2	Nozzle Partition	1
	4012001-458P1	Nozzle Partition	15
	4012001-458P2	Nozzle Partition	4
	4012001-458P3	Nozzle Partition	17

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
71	ZL2669-9-048	Nut - Shank	8
	ZL2715-14-054	Nut - Shank	4
	4012001-452	Scroll Contour	--
72	4012001-461G1 or G2	Seal - Outer	33
73	4012001-462G1 or G2	Seal - Inner	33
74	MS9062-15	Bolt	4
75	R297P04	Lockwire	AR
76	4012001-463G1	Seal - End	2
77	4012001-468P1	Clevis 90°	1
78	4012001-469P1	Clevis 7°30'	1
79	4012001-470P1	Clevis 172°30'	1
80	4012001-471P1-P5	Shim	AR
81	4012001-472P1-P5	Shim	AR
82	4012001-473P1	Bearing - Spherical	2
83	4012001-473P2	Bearing - Spherical	1
84	4012001-520G1	Lever Arm	7
	ZL2440-5-02	Shank Nut	7
85	4012001-521G1	Lever Arm	6
	ZL2440-5-02	Shank Nut	6
86	4012001-617P1	Bearing	12
87	4012001-618P1	Turnbuckle	6
88	4012001-619P1	Pin	8
89	4012001-623P1	Nut - Check	12
90	5002-118	Snap Ring	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
91	N5008-81	Snap Ring	2
92	5100-25	Snap Ring	12
93	1802-048	Nut	13
94	ZL2440-10-02	Nut	24
95	42H-24093 - Items 3,5,7, 9,11,13,15,17,19,21 & 23	Insulation Blanket	1
96	MS9033-06	Bolt	13
97	42H-24098 - Items 3,5,7, 9,11 & 13	Insulated Blanket	1
98	AN815-4	Nipple - Tube	1
99	4012001-331G2	Seal - Compressor	1
100	4012153-717P1	Stud	8
101	4012001-436P1	Hanger Circular Vane	4
102	NAS-464-3A-22	Bolt	4
103	1802-02	Nut	4

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-640G1	Assembly - Rear Frame, Left	X
2	4012001-600G2	Rear Frame - Left	1
	4012001-604G1	Turbine Vane	41
	4012001-603G1	Compressor Vane	88
	4012001-602	Instrumentation Drawing	--
	ZA1-1200-02	Anchor Nut	90
	AN125421	Rivet	180
	ZL2440-5-02	Shank Nut	76
3	4012001-805G1	Louver #1 Exit - Turbine	1
4	4012001-760G2	Louver #2 Exit - Turbine	1
	AN123371	Rivet	12
	AN123336	Rivet	4
	ZL2440-11-048	Nut - Shank	2
	4012001-780P1	Seat - Serrated	2
5	4012001-761G1	Louver #3 Exit - Turbine	1
6	4012001-761G2	Louver #4 Exit - Turbine	1
7	4012001-761G3	Louver #5 Exit - Turbine	1
8	4012001-761G4	Louver #6 Exit - Turbine	1
9	4012001-761G5	Louver #7 Exit - Turbine	1
10	4012001-761G6	Louver #8 Exit - Turbine	1
11	4012001-762G1	Louver #9 Exit - Turbine	1
12	4012001-762G2	Louver #10 Exit - Turbine	1
13	4012001-762G3	Louver #11 Exit - Turbine	1
14	4012001-762G4	Louver #12 Exit - Turbine	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
15	4012001-803G1	Louver #13	1
16	4012001-763G2	Louver #14, Exit - Turbine	1
	4012001-780P1	Seat - Serrated	2
	AN123371	Rivet	12
	AN123336	Rivet	4
	ZL2440-11-048	Shank Nut	2
17	4012153-748G1	Louver #15, Exit - Compressor	1
18	4012153-748G2	Louver #16, Exit - Compressor	1
19	4012153-748G3	Louver #17, Exit - Compressor	1
20	4012153-748G4	Louver #18, Exit - Compressor	1
21	4012153-748G5	Louver #19, Exit - Compressor	1
22	4012153-748G6	Louver #20, Exit - Compressor	1
23	4012153-748G7	Louver #21, Exit - Compressor	1
24	4012153-748G8	Louver #22, Exit - Compressor	1
25	4012153-748G9	Louver #23, Exit - Compressor	1
26	4012153-748G10	Louver #24, Exit - Compressor	1
27	4012153-748 G11	Louver #25, Exit - Compressor	1
	4012001-780P1	Seat - Serrated	11
	MD420BS	Rivet	44
	MS20470B6-8	Rivet	66
	AN123190	Rivet	77
	ZL2440-11-048	Shank Nut	11
	MS20470B6-16	Rivet	55
28	4012001-766G1	Louver #26, Exit - Turbine	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
29	4012001-767G2	Louver #27, Exit - Turbine	1
	AN123371	Rivet	12
	AN123335	Rivet	4
	ZL-2440-11-048	Shank Nut	2
	4012001-780P1	Seat - Serrated	2
30	4012153-748G12	Louver #28, Exit - Compressor	1
31	4012153-748G13	Louver #29, Exit - Compressor	1
32	4012153-748G14	Louver #30, Exit - Compressor	1
33	4012153-748G15	Louver #31, Exit - Compressor	1
34	4012153-748G16	Louver #32, Exit - Compressor	1
35	4012153-748G17	Louver #33, Exit - Compressor	1
36	4012153-748G18	Louver #34, Exit - Compressor	1
37	4012153-748G19	Louver #35, Exit - Compressor	1
38	4012153-748G20	Louver #36, Exit - Compressor	1
39	4012153-748G21	Louver #37, Exit - Compressor	1
	MS20470B6-16	Rivet	50
	AN123190	Rivet	70
	MD420B9	Rivet	40
	4012001-780P1	Seat - Serrated	10
	ZL2440-11-048	Shank Nut	10
	MS20470B6-8	Rivet	60
40			
41	4012001-750G1	Bearing Support	7
42	4012001-750G2	Bearing Support	8

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
43	4012001-751G1	Bearing Support	1
44	4012001-751G2	Bearing Support	1
45	4012001-751G3	Bearing Support	1
46	4012001-751G4	Bearing Support	1
47	4012001-751G5	Bearing Support	1
48	4012001-751G6	Bearing Support	1
49	4012001-751G7	Bearing Support	3
50	4012001-751G8	Bearing Support	1
51	4012001-751G9	Bearing Support	1
52	4012001-751G10	Bearing Support	1
53	4012001-751G11	Bearing Support	1
54	4012001-751G12	Bearing Support	1
55	4012001-751G13	Bearing Support	1
56	4012001-752G1	Bearing Support	1
57	4012001-752G2	Bearing Support	2
58	4012001-753G1	Bearing Support	2
59	4012001-753G2	Bearing Support	2
60	4012001-754P1	Bushing	7
61	4012001-754P2	Bushing	2
62	4012001-754P3	Bushing	2
63	4012001-754P4	Bushing	2
64	4012001-754P5	Bushing	12
65	4012001-754P6	Bushing	12
66	4012001-786P5	Shim	AR

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
67	4012001-786P6	Shim	AR
68	4012001-786P7	Shim	AR
69	4012001-786P8	Shim	AR
70	MS9033-08	Bolt	74
71	AN960C10L	Washer	AR
72	4012001-601G1	Seal	9
73	4012001-601G3	Seal	24
74	MS21288-06	Bolt	90
75	4012001-613G2	Insulation Blanket	1
76	4012001-615G1	Insulation Blanket	1
77	AN104608	Bolt	75
78	1803-02	Nut	75
79	4012001-788P1	Washer	1
80	R297P04	Lockwire	AR
81	4012001-755P1	Pin	10
82	4012001-783P1	Bushing	28
83	4012001-784P2	Shaft	14
84	4012001-756P2	Lever Arm - Louver	27
85	4012001-785P1	Bolt	27
86	AN960C416L	Washer	27
87	4012001-782P1	Lever Arm Push Rod	14
88	4012160-140G1	Push Rod (Fwd.)	1
89	4012153-695G2	Push Rod (Aft)	1
90	4012153-759P2	Pin	14

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
91	AN381-15-5	Cotter Pin	14
92			
93	4012153-709P1	Bolt - Shoulder	1
94	MS9245-30	Pin - Cotter	1
95	MS35692-510	Nut - Castle	1
96			
97	4012153-726P1	Cam Push Rod Act.	1
98	4012153-721P1	Link - Push Rod	1
99	4012001-794P1	Pin - Headed	1
100	4012001-794P2	Pin - Headed	1
101	5100-31	Snap Ring	2
102	AN381-2-8	Cotter Pin	1
103	4012153-702P3	Slave Link	1
104	4012001-789P1	Plug	1
105	R432P22	Bolt	1
106	4012153-701P3	Link	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-190G2	Assembly - Rotor, Left	
2	4012001-148G1	Disc and Shaft Assembly	1
	4012001-148P5 70ZEB1845-054	Disc Dowel Nut	36 72
	AN960C516	Washer	AR
3	4012001-163G1	Ring - Platform Retainer	2
	70ZAIWP-02	Nut - Anchor (Mod)	72
4	4012001-165P1	Weight - Balance	AR
5			
6			
7	4012001-147P1	Blade (Mach)	36
8	4012001-145G2	Bucket Carrier	18
	4012001-146G1	Bucket (Fab)	324
9	4012001-155G1	Seal - Bucket Carrier	18
10	4012001-208G1	Torque Band	12
11	4012001-206P1	Bolt	180
12	4012001-169P1	Tab - Carrier	72
13	4012001-167P1	Pin - Retainer	36
14	4012001-171P5	Pin - Retainer	36
15	4012001-166P1	Strip - Locking	36
16	4012001-156G2	Cover - Bucket Carrier	18
	MT12C1032P	Nut	72
17	4012001-156G4	Cover - Bucket Carrier	18
	MT12C1032P	Nut	36
18	4012001-176P1	Washer	AR

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
19			
20	4012001-159G2	Platform (Fab)	36

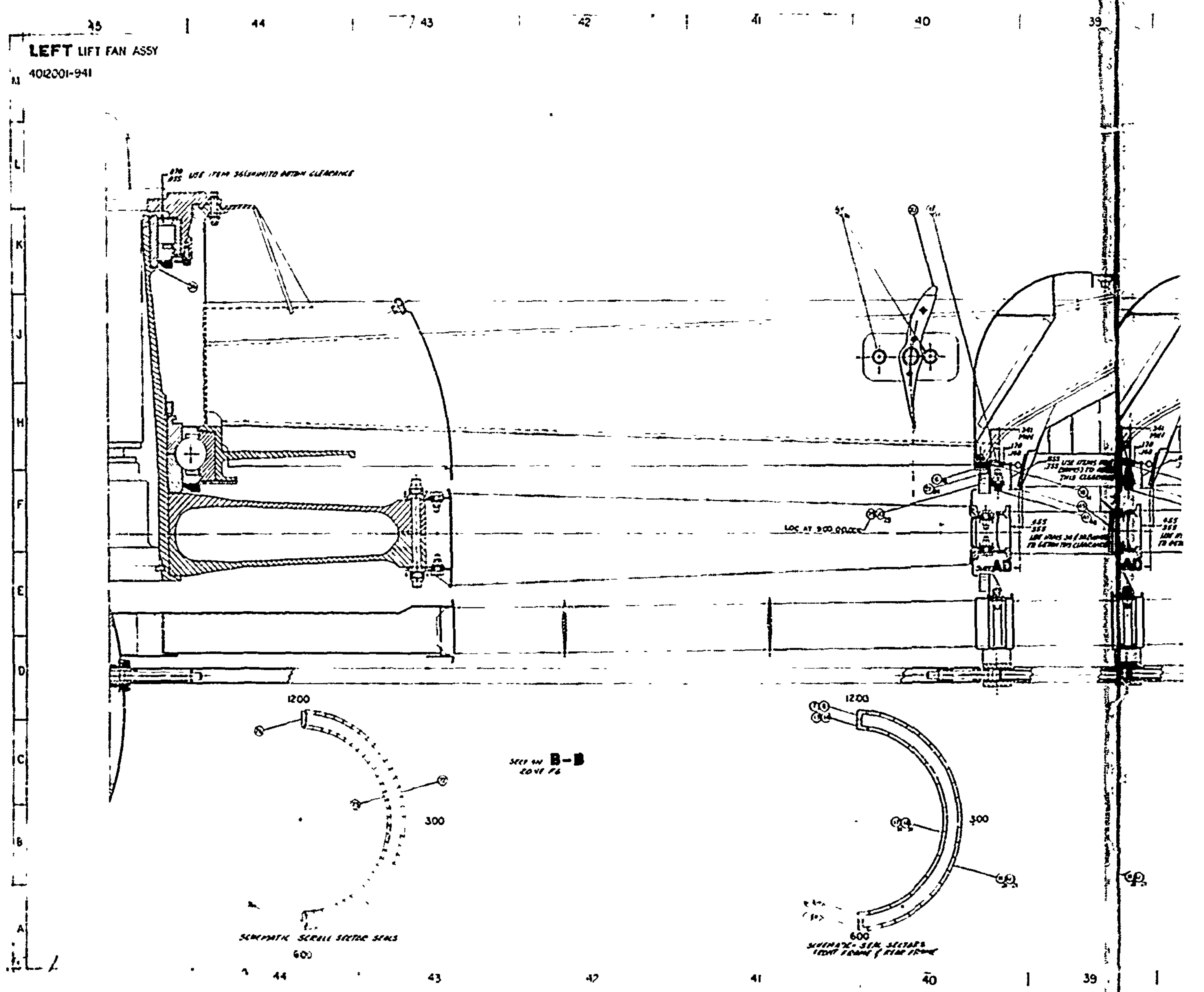
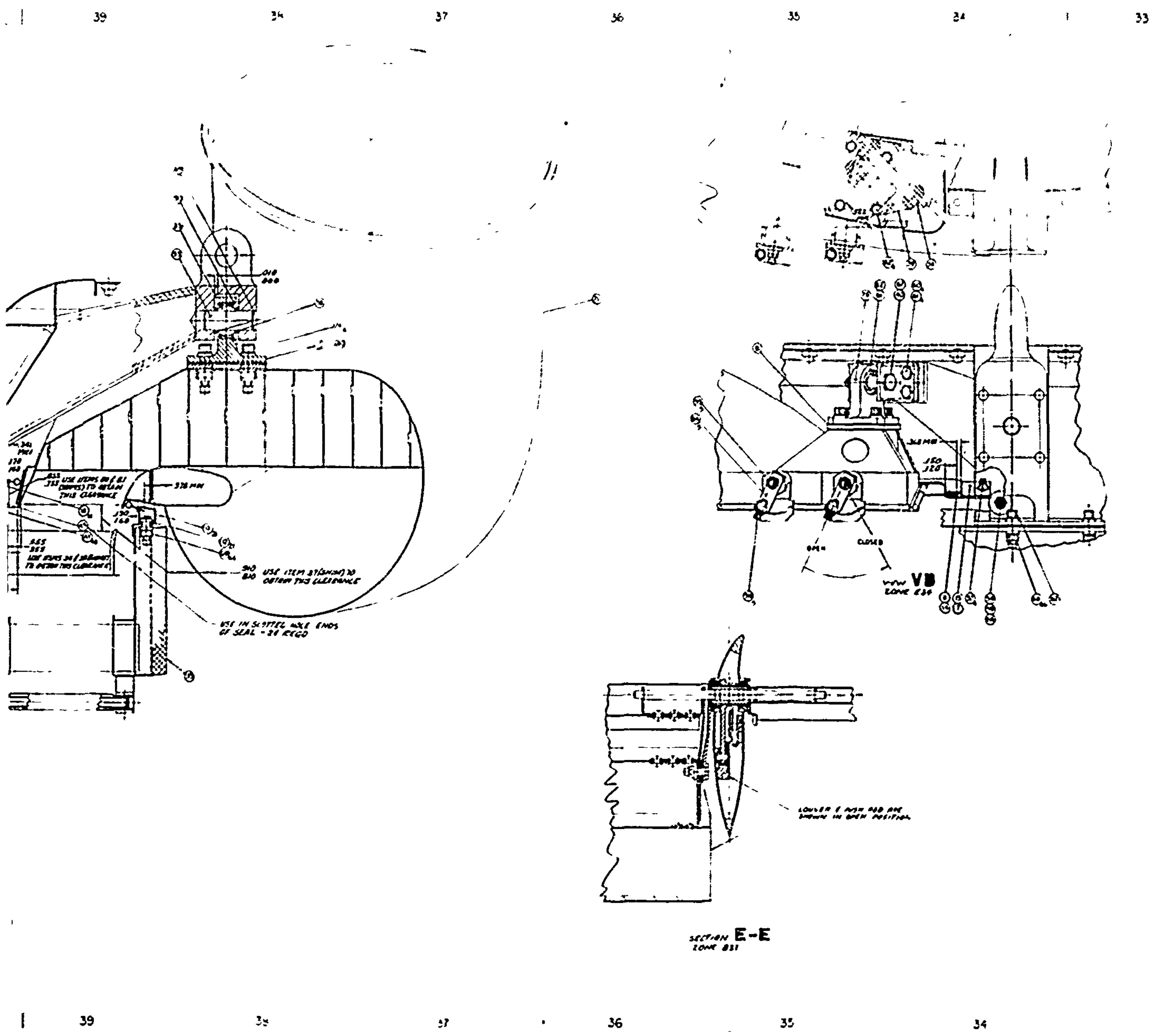


FIGURE 4.1 LIFT FAN BASIC ASSEMBSIC AS
(4012001-941) Sheet 1) Sh

I-4.49



C ASSEMBLY DRAWING (LEFT)
Sheet 1 of 4

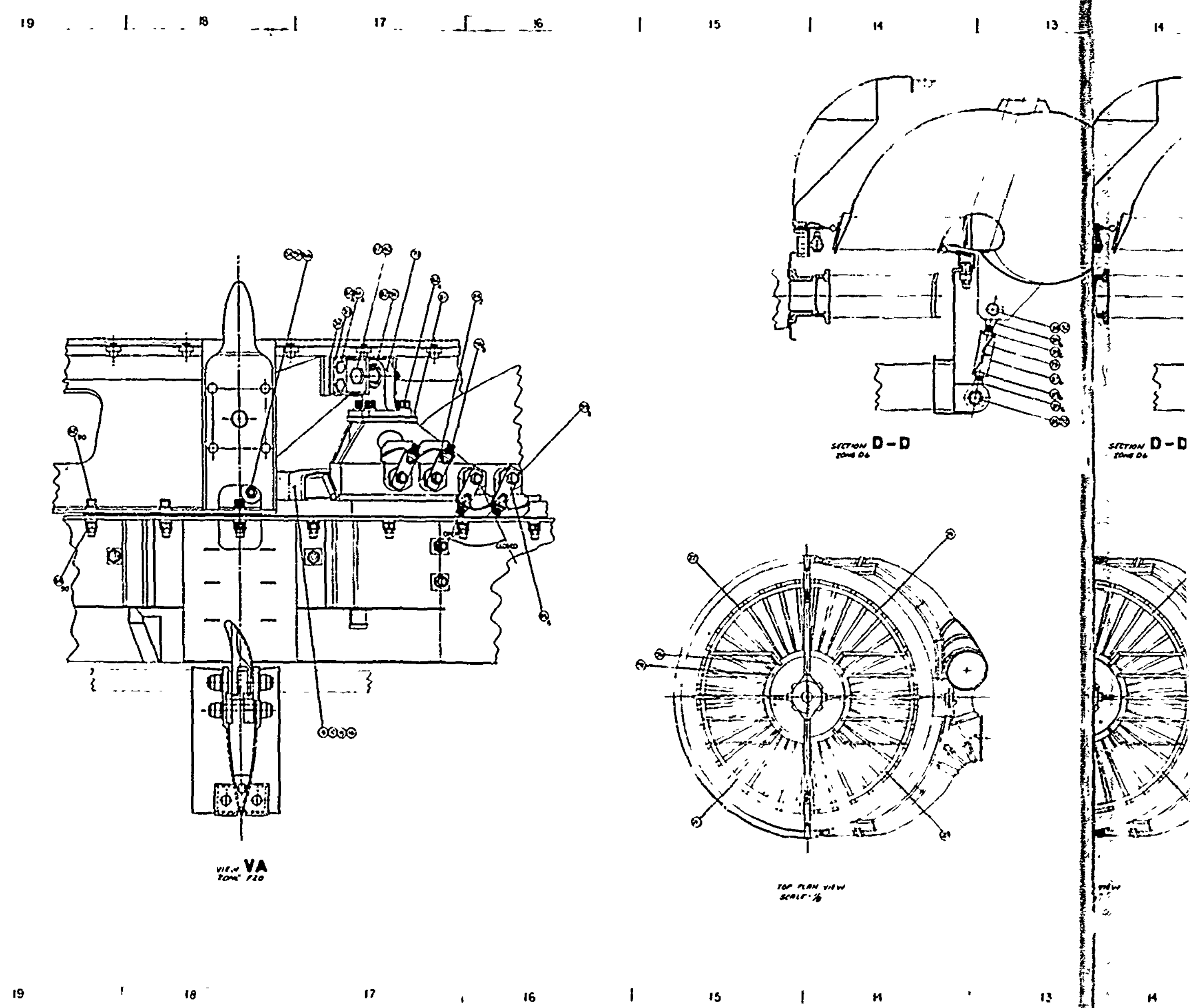
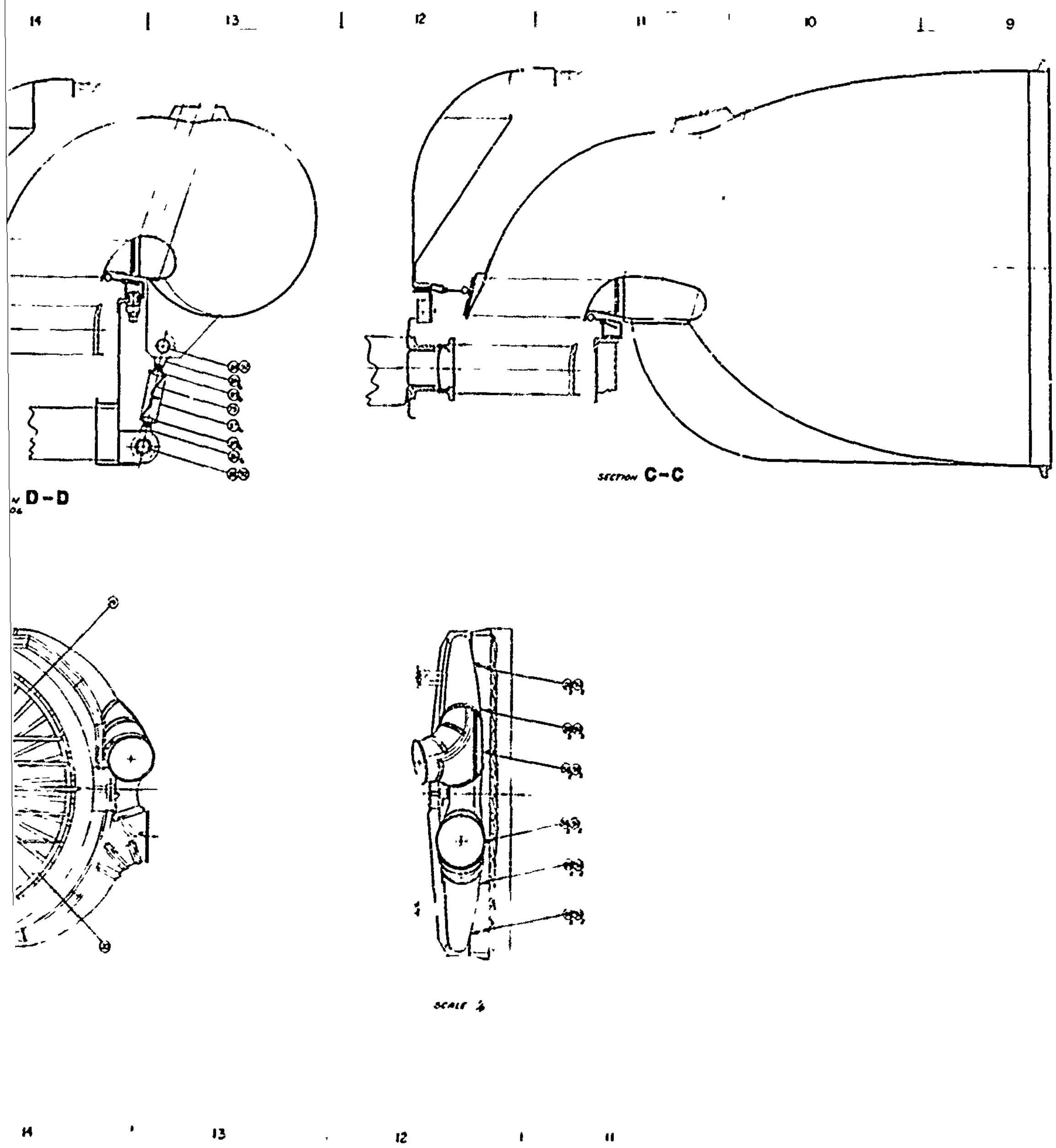


FIGURE 4.1 LIFT FAN BASIC ASSEMBLY DRAWN BASIC
(4012001-941) Sheet 3 of 401-941)

A



ASIC ASSEMBLY DRAWING (LEFT)
41) Sheet 3 of 4

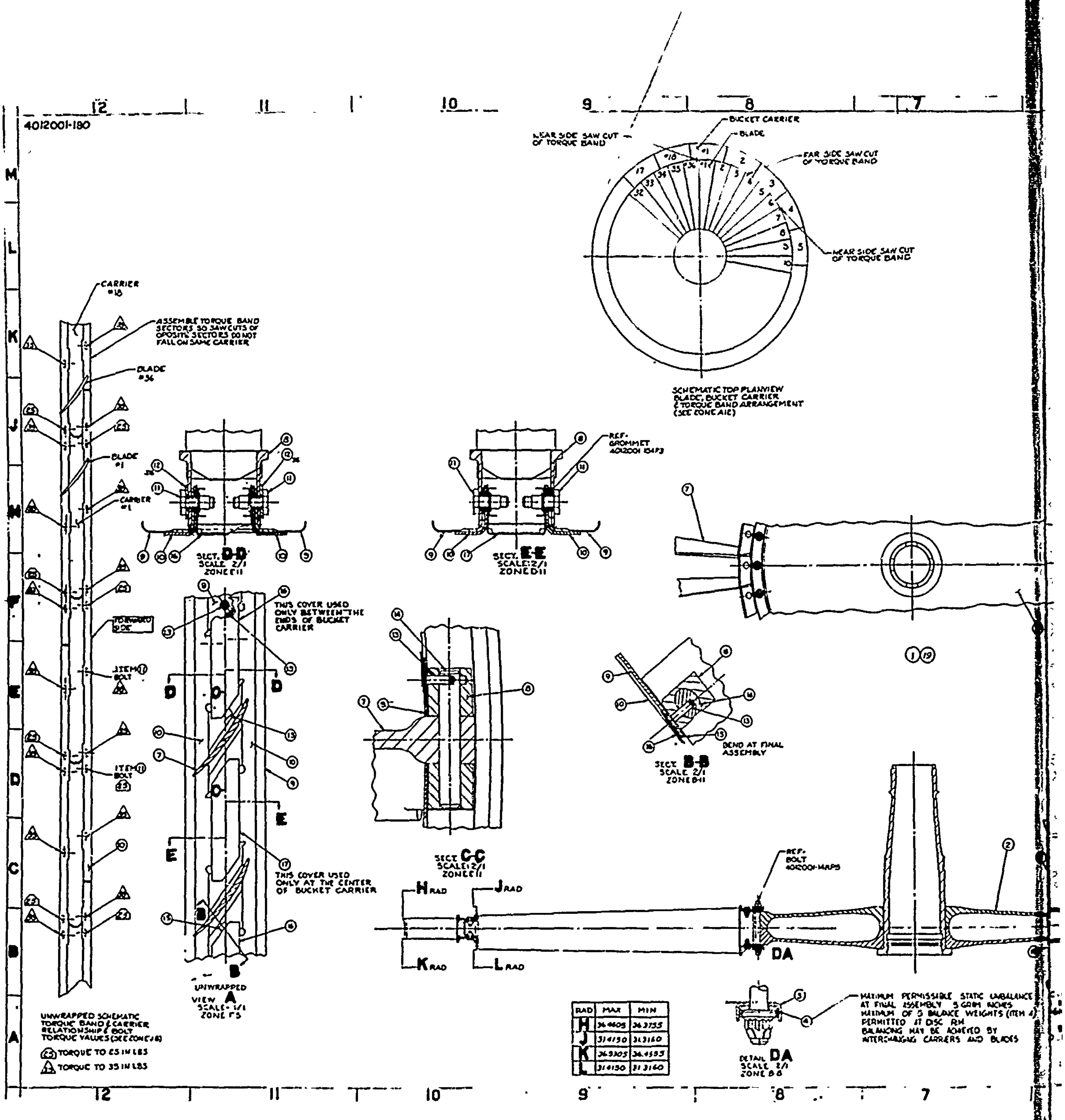
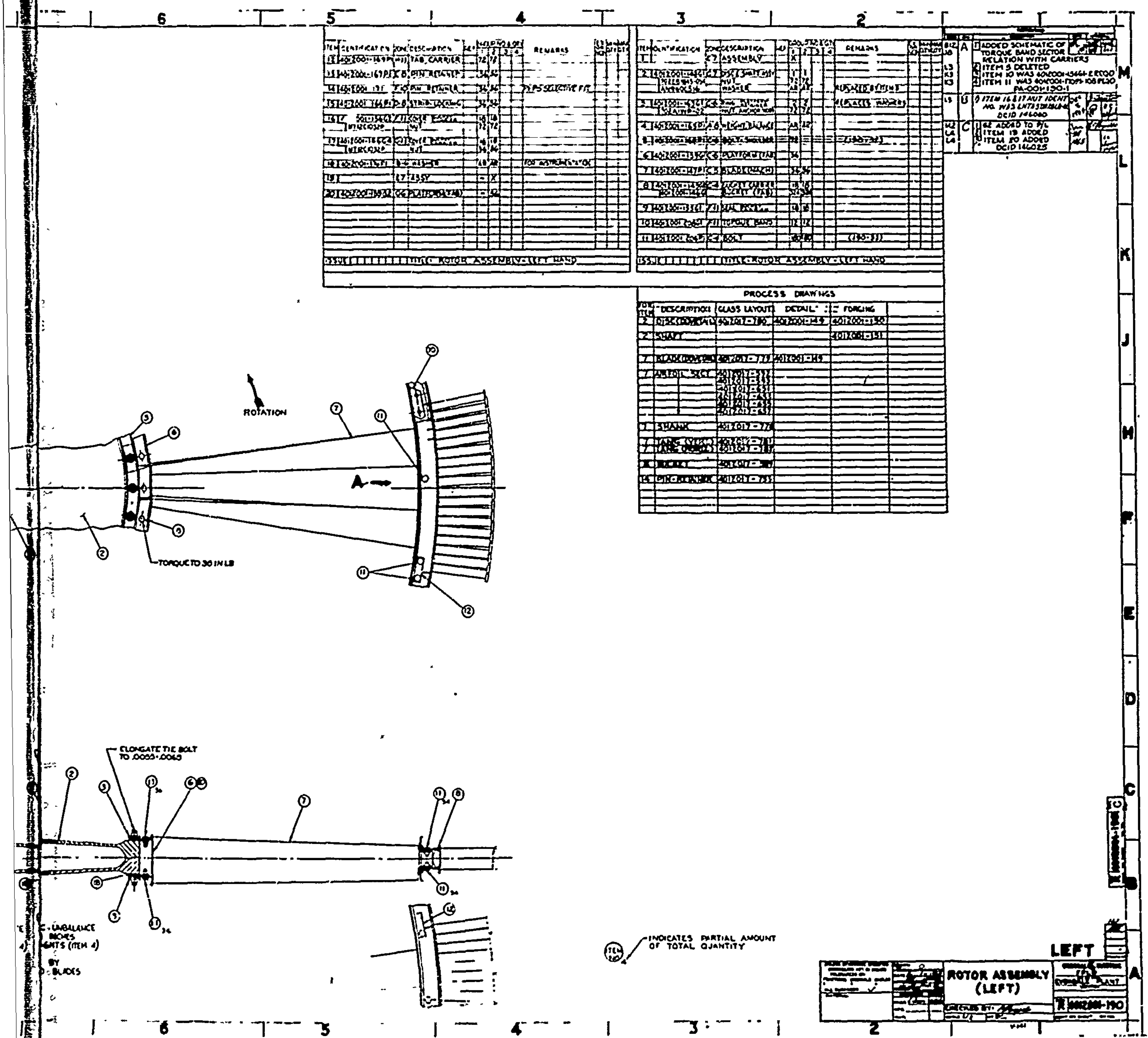


FIGURE 4.2 LIFT FAN ROTOR
(4012001-190)



ROTOR ASSEMBLY DRAWING (LEFT)
190) Sheet 1 of 1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-942G1	Assembly - Right	X
2	4012001-191G2	Rotor Assembly	1
3	4012001-183G1	Slip Ring Assembly	1
	4012001-178G1	Adapter	1
	4012001-179P1	Key	1
	4012001-180P1	Retainer	1
	4012001-181P1	Key	8
	4012001-182P1	Connector	1
	5000-212W	Snap Ring	1
	5000-387W	Snap Ring	1
	4012001-230P1	Ring - Retaining	1
4	MS24678-21	Bolt, Internal Wrenching	4
5	4012001-300G2	Front Frame	1
	LHSS-6	Bearing	2
	ZL2440-11-048	Nut - Shank	8
	ZL2440-10-02	Nut - Shank	48
	ZL2440-5-048	Nut - Shank	16
	ZL3850-8-064	Nut - Shank	4
	ZA21-1200-02	Nut - Anchor	20
	70 Z AIW-02	Nut - Anchor	4
	AN435M3-5	Rivet	8
	CR-562-4-4	Rivet	48
	4012001-302	Instrumentation	--
	4012001-301	Bellmouth Contour	--

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
5	AN124972	Rivet	40
	AN427M3-5	Rivet	148
	MF1000-3	Nut - Anchor	74
6	4012001-170P2	Bolt	48
7	4012001-306G1	Seal Corner	1
	4012001-327P1	Bolt	1
8	4012001-307G1	Seal Corner	1
9	4012001-308G1	Seal Corner	1
	4012001-327P1	Bolt	1
10	4012001-309G1	Seal Corner	1
11	4012001-310G1	Seal Sector	21
	4012001-327P1	Bolt	42
12	4012001-311G1	Seal Sector	21
13	4012001-312G1	Seal Corner	1
14	4012001-313G1	Seal Corner	1
15	4012001-314G1	Seal Corner	1
16	4012001-315G1	Seal Corner	1
17	4012001-316G1	Seal Sector	11
18	4012001-317G1	Seal Sector	11
19	4012001-405G2	Vane Quadrant	1
20	4012001-405G3	Vane Quadrant	1
21	4012001-405G4	Vane Quadrant	1
22	4012001-405G5	Vane Quadrant	1
	MS51975-16	Bolt	4

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
22	59FAF-518	Nut	4
	RRN-68	Snap Ring	4
	LHSSVV-4	Bearing	4
	4012001-429P1	Pad	2
	R105P2SL	Bolt	8
	4012001-430P1	Retainer, Bearing	4
	LHSS-5	Bearing	4
	4012001-432P1	Washer	AR
	R398P1	Nut	4
	4012001-431P1,P2 or P3	Spacer	AR
	4012001-429P2	Pad	2
	4012001-417P1	Pad	2
	4012001-417P2	Pad	2
23	4012001-322P2	Bearing - Roller	1
24	4012001-323P2	Bearing - Ball	1
25	4012001-324P1	Seal - Grease	1
26	4012001-324P2	Seal - Grease	1
27	4012001-325P1	Shield - Grease	2
28	4012001-326P1	Retainer - Seal	1
29	4012001-330G1	Housing - Bearing	1
	AN122683	Dowel Pin	1
30	4012001-331G1	Seal - Compressor	23
31	4012001-332G1	Support - Seal	24
	Z2440-3-02	Nut - Shank	24

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
32	4012001-337G1	Blanket - Insulation	1
33	4012001-340P1	Retainer - Seal	1
34	4012001-342P1 thru P5	Shim	AR
35	4012001-343P1	Shield - Grease	1
36	4012001-345P1 or P2	Shim - Bearing	AR
37	4012001-346P1 or P2	Shim - Bearing	AR
38	4012001-348P1 or P2	Spacer	AR
39	4012001-351P1	Clevis	2
40	4012001-352P1	Bolt	2
41	4012001-362P1	Bolt	48
42	4012001-363P1	Shield - Grease	1
43	4012001-364P1	Washer	24
44	4012001-365G1	Bushing	1
45	4012001-366P1	Nut	1
46	4012001-367P1	Nut - Spanner	1
47	4012001-368P1	Washer - Tab	1
48	4012001-370P1	Retainer - Bearing	2
49	4012001-371P3	Pickup - RPM	1
50	4012001-372P1	Spacer	AR
51	4012153-117P2	Bolt	8
52	4012153-250P1	Bolt	4
53	4012001-347P1	Pin	1
54	AN104608	Bolt	66
55	AN509C10-9	Screw	16

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
56	R113P14UL	Bolt	8
57	R106P4SL	Bolt	16
58	4012001-619P2	Pin	4
59	AN960C10L	Washer	26
60	MS20033-2	Bolt	8
61	MS20500-1032	Nut	8
62	MS9034-12	Bolt	98
63	MS9200-07	Nut	1
64	MS9088-08	Bolt	12
65	MS9088-12	Bolt	8
66	1803-02	Nut	46
67	Z1835-054	Nut	2
68	Z1855-048	Nut	90
69	N5000-62	Snap Ring	1
70	4012001-641G1	Rear Frame - Right Assembly	1
71	4012001-460G4	Scroll - Right	1
	4012001-451P1	Vane - Splitter	8
	4012001-459P1	Vane - Splitter	5
	4012001-456P1	Strut	15
	4012001-457P1	Nozzle Partition	33
	4012001-457P2	Nozzle Partition	4
	4012001-458P1	Nozzle Partition	15
	4012001-458P2	Nozzle Partition	1
	4012001-458P3	Nozzle Partition	16

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
71	ZL2669-9-048	Nut - Shank	8
	ZL2715-14-054	Nut - Shank	4
	4012001-452	Scroll Contour	--
72	4012001-461G1 or G2	Seal - Outer	33
73	4012001-462G1 or G2	Seal - Inner	33
74	M39062-15	Bolt	4
75	R297P04	Lockwire	AR
76	4012001-463G1	Seal - End	2
77	4012001-468P1	Clevis 90°	1
78	4012001-469P1	Clevis 7°30'	1
79	4012001-470P1	Clevis 172°30'	1
80	4012001-471P1-P5	Shim	AR
81	4012001-472P1-P5	Shim	AR
82	4012001-473P1	Bearing - Spherical	2
83	4012001-473P2	Bearing - Spherical	1
84	4012001-520G1	Lever Arm	7
	ZL2440-5-02	Shank Nut	7
85	4012001-521G1	Lever Arm	6
	ZL2440-5-02	Shank Nut	6
86	4012001-617P1	Bearing	12
87	4012001-618P1	Turnbuckle	6
88	4012001-619P1	Pin	8
89	4012001-623P1	Nut - Check	12
90	5002-118	Snap Ring	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
91	N5008-81	Snap Ring	2
92	5100-25	Snap Ring	12
93	1802-048	Nut	13
94	ZL2440-10-02	Nut	24
95	42H-24093 - Items 3,5,7, 9,11,13,15,17,19,21,23	Insulation Blanket	1
96	MS9033-06	Bolt	13
97	42H-24098 - Items 4,6, 8,10,12,14	Insultation Blanket	1
98	AN815-4	Nipple - Tube	1
99	4012001-331G2	Seal - Compressor	1
100	4012153-717P1	Stud	8
101	4012001-436P1	Hanger, Circular Vane	4
102	NAS-464-3A-22	Bolt	4
103	1802-02	Nut	4

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-641G1	Assembly, Rear Frame - Right	X
2	4012001-606G2	Rear Frame - Right	1
	4012001-609G1	Turbine Vane	41
	4012001-608G1	Compressor Vane	88
	4012001-607	Instrumentation Drawing	--
	ZA1-1200-02	Anchor Nut	90
	AN125421	Rivet	180
	ZL2440-5-02	Shank Nut	76
3	4012001-806G1	Louver #1 Exit - Turbine	1
4	4012001-770G2	Louver #2 Exit - Turbine	1
	AN123371	Rivet	12
	AN123336	Rivet	4
	ZL2440-11-048	Nut - Shank	2
	4012001-780P1	Seat - Serrated	2
5	4012001-771G1	Louver #3 Exit - Turbine	1
6	4012001-771G2	Louver #4 Exit - Turbine	1
7	4012001-771G3	Louver #5 Exit - Turbine	1
8	4012001-771G4	Louver #6 Exit - Turbine	1
9	4012001-771G5	Louver #7 Exit - Turbine	1
10	4012001-771G6	Louver #8 Exit - Turbine	1
11	4012001-772G1	Louver #9 Exit - Turbine	1
12	4012001-772G2	Louver #10 Exit - Turbine	1
13	4012001-772G3	Louver #11 Exit - Turbine	1
14	4012001-772G4	Louver #12 Exit - Turbine	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
15	4012001-804G1	Louver #13, Exit - Turbine	1
16	4012001-773G2	Louver #14, Exit - Turbine	1
	4012001-780P1	Seat - Serrated	2
	AN123371	Rivet	12
	AN123336	Rivet	4
	ZL2440-11-048	Shank Nut	2
17	4012153-749G1	Louver #15, Exit - Compressor	1
18	4012153-749G2	Louver #16, Exit - Compressor	1
19	4012153-749G3	Louver #17, Exit - Compressor	1
20	4012153-749G4	Louver #18, Exit - Compressor	1
21	4012153-749G5	Louver #19, Exit - Compressor	1
22	4012153-749G6	Louver #20, Exit - Compressor	1
23	4012153-749G7	Louver #21, Exit - Compressor	1
24	4012153-749G8	Louver #22, Exit - Compressor	1
25	4012153-749G9	Louver #23, Exit - Compressor	1
26	4012153-749G10	Louver #24, Exit - Compressor	1
27	4012153-749G11	Louver #25, Exit - Compressor	1
	4012001-780P1	Seat - Serrated	11
	MD420BS	Rivet	44
	MS20470B6-8	Rivet	66
	AN123190	Rivet	77
	AL2440-11-048	Shank Nut	11
	MS20470B6-16	Rivet	55
28	4012001-776G1	Louver #26, Exit - Turbine	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
29	4012001-777G2	Louver #27, Exit - Turbine	1
	AN123371	Rivet	12
	AN123336	Rivet	4
	ZL-2440-11-048	Shank - Nut	2
	4012001-780P1	Seat - Serrated	2
30	4012153-749G12	Louver #28, Exit - Compressor	1
31	4012153-749G13	Louver #29, Exit - Compressor	1
32	4012153-749G14	Louver #30, Exit - Compressor	1
33	4012153-749G15	Louver #31, Exit - Compressor	1
34	4012153-749G16	Louver #32, Exit - Compressor	1
35	4012153-749G17	Louver #33, Exit - Compressor	1
36	4012153-749G18	Louver #34, Exit - Compressor	1
37	4012153-749G19	Louver #35, Exit - Compressor	1
38	4012153-749G20	Louver #36, Exit - Compressor	1
39	4012153-749G21	Louver #37, Exit - Compressor	1
	MS20470B6-16	Rivet	50
	AN123190	Rivet	70
	MD420BS	Rivet	40
	4012001-780P1	Seat - Serrated	10
	ZL2440-11-048	Shank Nut	10
	MS20470B6-8	Rivet	60
40			
41	4012001-750G1	Bearing Support	7
42	4012001-750G2	Bearing Support	8

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
43	4012001-751G1	Bearing Support	1
44	4012001-751G2	Bearing Support	1
45	4012001-751G3	Bearing Support	1
46	4012001-751G4	Bearing Support	1
47	4012001-751G5	Bearing Support	1
48	4012001-751G6	Bearing Support	1
49	4012001-750G7	Bearing Support	3
50	4012001-751G8	Bearing Support	1
51	4012001-751G9	Bearing Support	1
52	4012001-751G10	Bearing Support	1
53	4012001-751G11	Bearing Support	1
54	4012001-751G12	Bearing Support	1
55	4012001-751G13	Bearing Support	1
56	4012001-752G1	Bearing Support	2
57	4012001-752G2	Bearing Support	2
58	4012001-753G1	Bearing Support	1
59	4012001-753G2	Bearing Support	2
60	4012001-754P1	Bushing	7
61	4012001-754P2	Bushing	2
62	4012001-754P3	Bushing	2
63	4012001-754P4	Bushing	2
64	4012001-754P5	Bushing	12
65	4012001-754P6	Bushing	12
66	4012001-786P5	Shim	AR

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
67	4012001-786P6	Shim	AR
68	4012001-786P7	Shim	AR
69	4012001-786P8	Shim	AR
70	MS9033-08	Bolt	74
71	AN960C10L	Washer	AR
72	4012001-601G1	Seal	9
73	4012001-601G3	Seal	24
74	MS21288-06	Bolt	90
75	4012001-614G2	Insulation Blanket	1
76	4012001-616G1	Insulation Blanket	1
77	AN104608	Bolt	75
78	1803-02	Nut	75
79	4012001-788P1	Washer	1
80	R297P04	Lockwire	AR
81	4012001-755P1	Pin	10
82	4012001-783P1	Bushing	28
83	4012001-784P2	Shaft	14
84	4012001-756P2	Lever Arm - Louver	27
85	4012001-785P1	Bolt	27
86	AN960C416L	Washer	27
87	4012001-782P1	Lever Arm - Push Rod	14
88	4012160-141G1	Push Rod - Forward	1
89	4012153-695G3	Push Rod - Aft	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
90	4012001-759P2	Pin	14
91	AN381-15-5	Cotter Pin	14
92			
93	4012153-709P1	Bolt - Shoulder	1
94	MS9245-30	Pin - Cotter	1
95	MS35692-510	Nut - Castle	1
96			
97	4012153-726P2	Cam - Push Rod Actuator	1
98	4012153-721P1	Link - Push Rod	1
99	4012001-794P1	Pin - Headed	1
100	4012001-794P2	Pin - Headed	1
101	5100-31	Snap Ring	2
102	AN381-2-8	Cotter Pin	1
103	4012153-702P4	Slave Link	1
104	4012001-789P1	Plug	1
105	R432P22	Bolt	1
106	4012153-701P4	Link	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-191G2	Assembly - Rotor - Right	-
2	4012001-157G1	Disc and Shaft Assembly	1
	4012001-148P5 70ZEB1845-054	Disc Dowel Nut	36 72
	AN960C516	Washer	AR
3	4012001-163G1	Ring - Platform Retainer	2
	70ZAIWP-02	Nut - Anchor (Mod)	72
4	4012001-165P1	Weight - Balance	AR
5			
6			
7	4012001-158P1	Blade (Mach)	36
8	4012001-152G2	Bucket Carrier	18
	4012001-153G1	Bucket (Fab)	324
9	4012001-161G1	Seal - Bucket Carrier	18
10	4012001-209G1	Torque Band	12
11	4012001-206P1	Bolt	180
12	4012001-169P1	Tab - Carrier	72
13	4012001-167P1	Pin - Retainer	36
14	4012001-171P1-P5	Pin - Retainer	36
15	4012001-166P1	Strip - Locking	36
16	4012001-162G2	Cover - Bucket Carrier	18
	MT12C1032P	Nut	72
17	4012001-162G4	Cover - Bucket Carrier	18
	MT12C1032P	Nut	36
18	4012001-176P1	Washer	AR

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
19			
20	4012001-164G2	Platform (Fab)	36

77

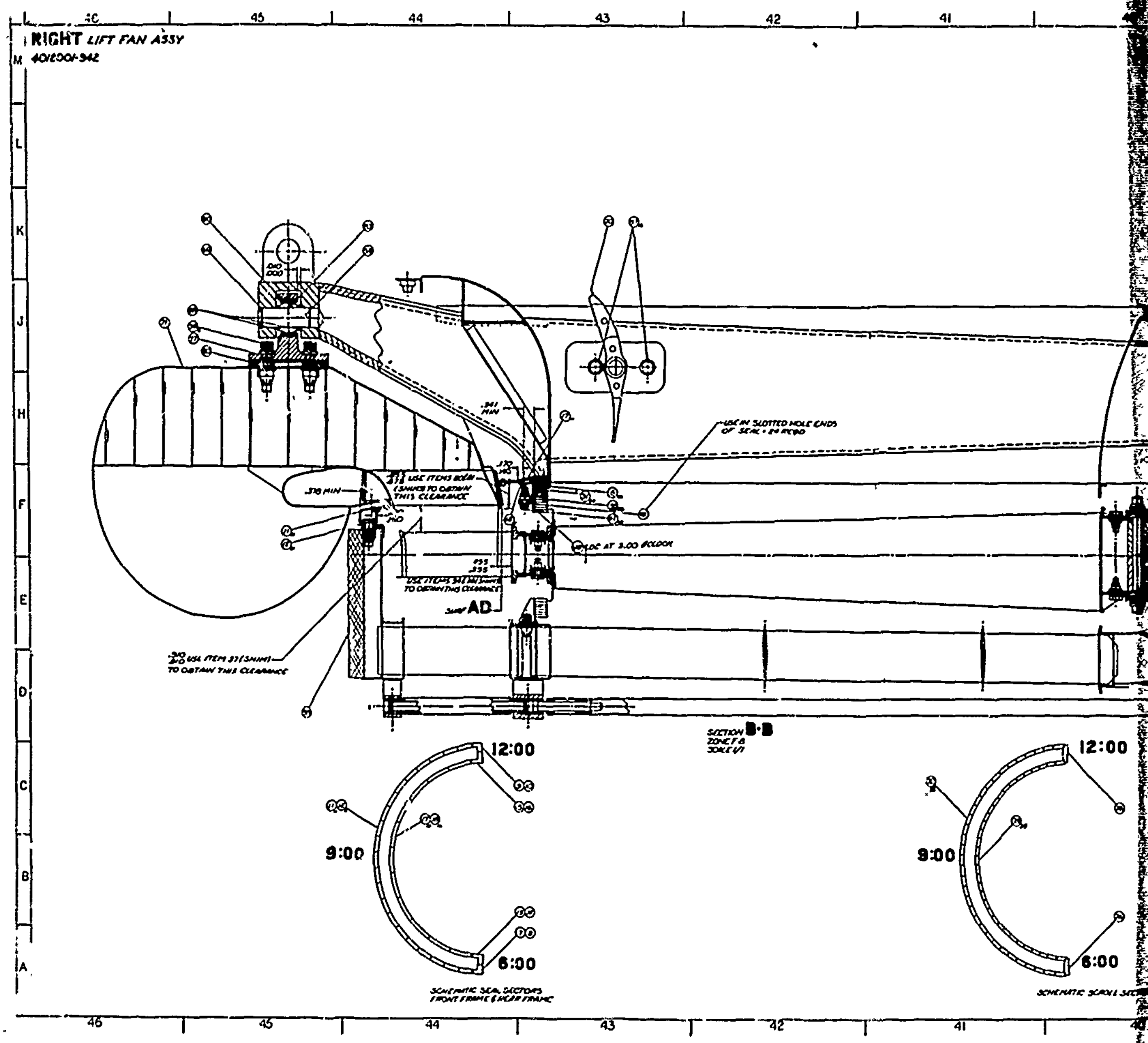
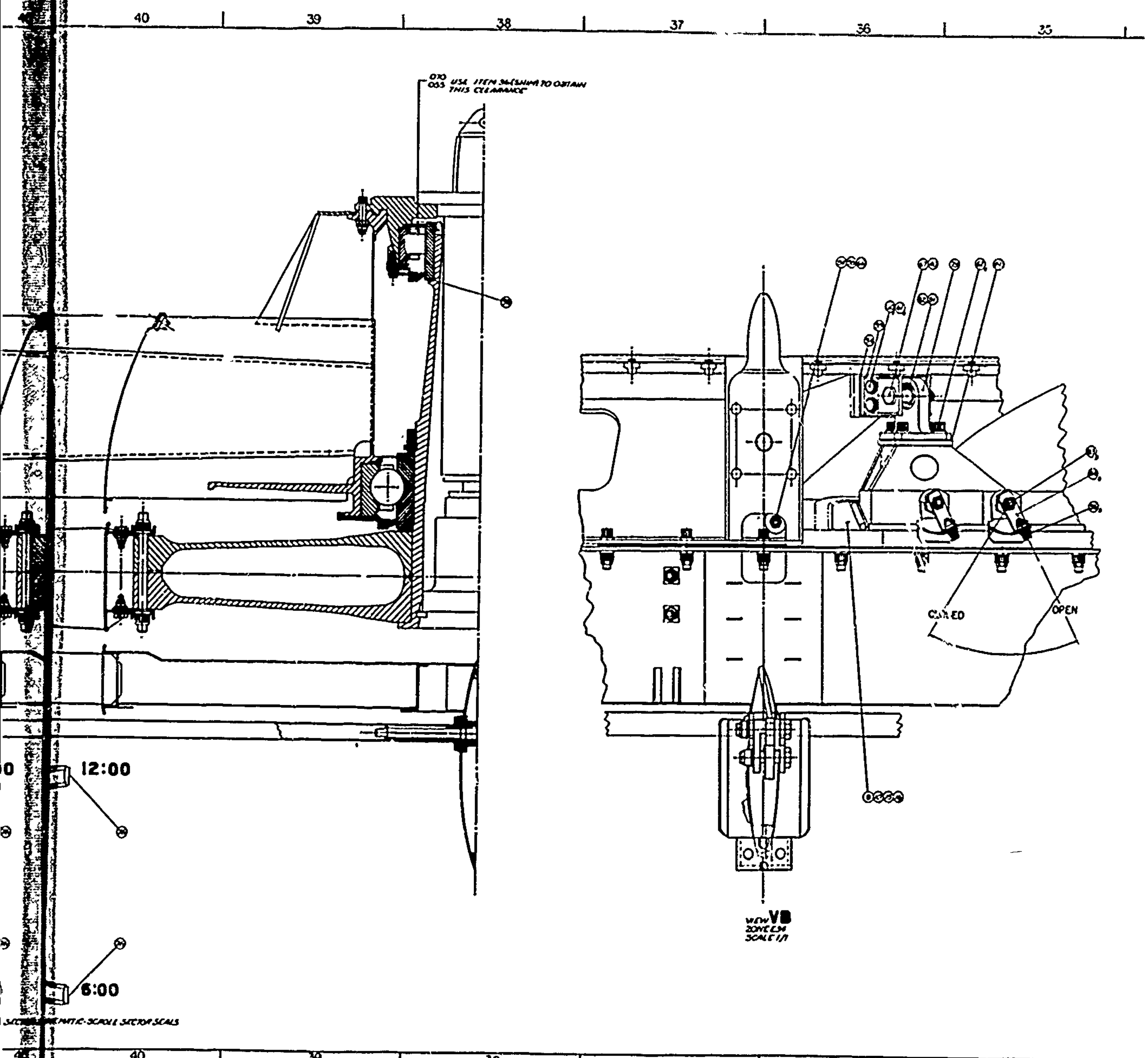


FIGURE 4.1A LIFT FAN BASIC ASSE
(4012001-942) Shee

A



EC ASSEMBL DRAWING (RIGHT)
Sheet 1 of 4

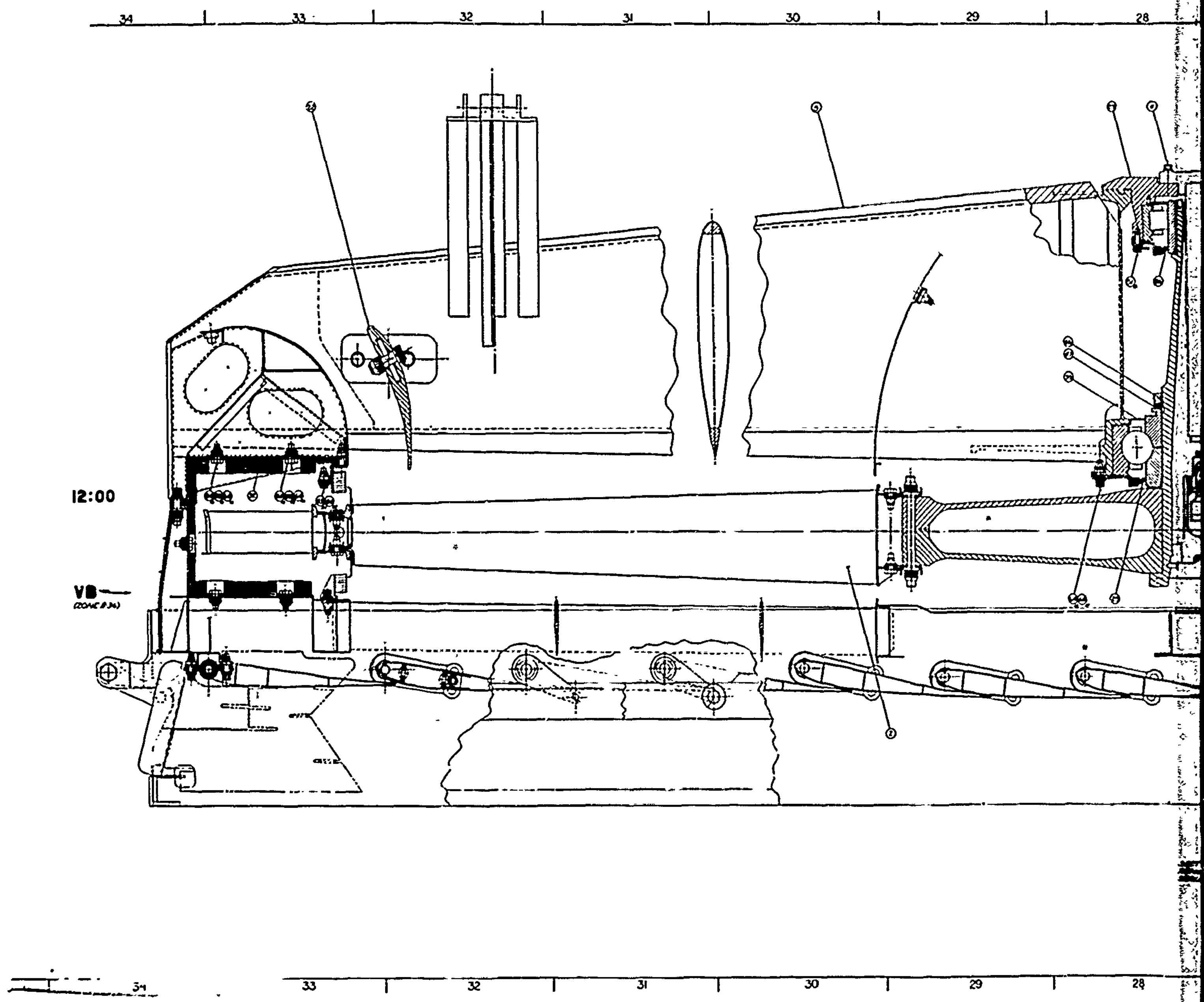
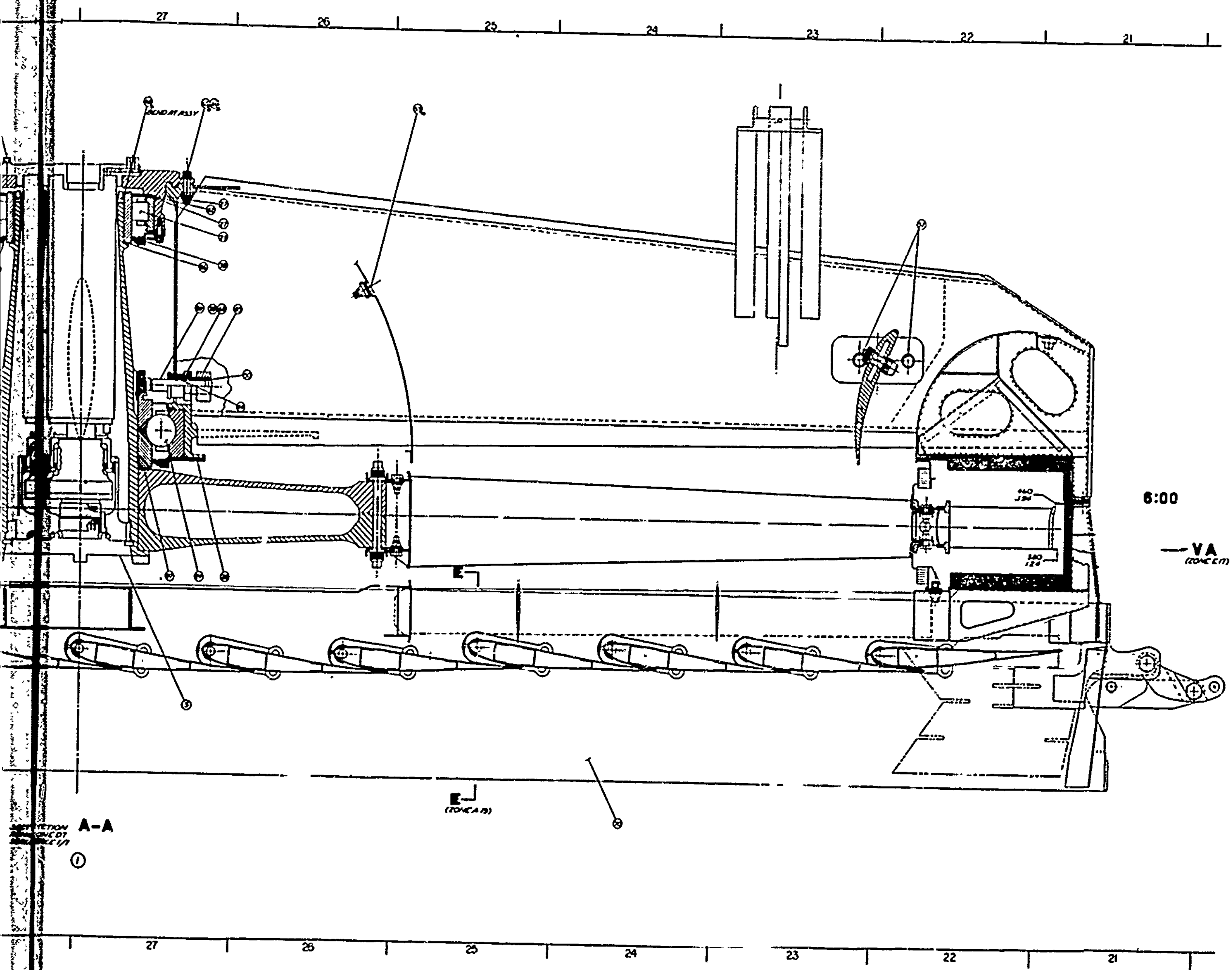


FIGURE 4.1A LIFT FAN
(4012001-

A

77



AN BASIC ASSEMBLY DRAWING (RIGHT)
-942) Sheet 2 of 4

B

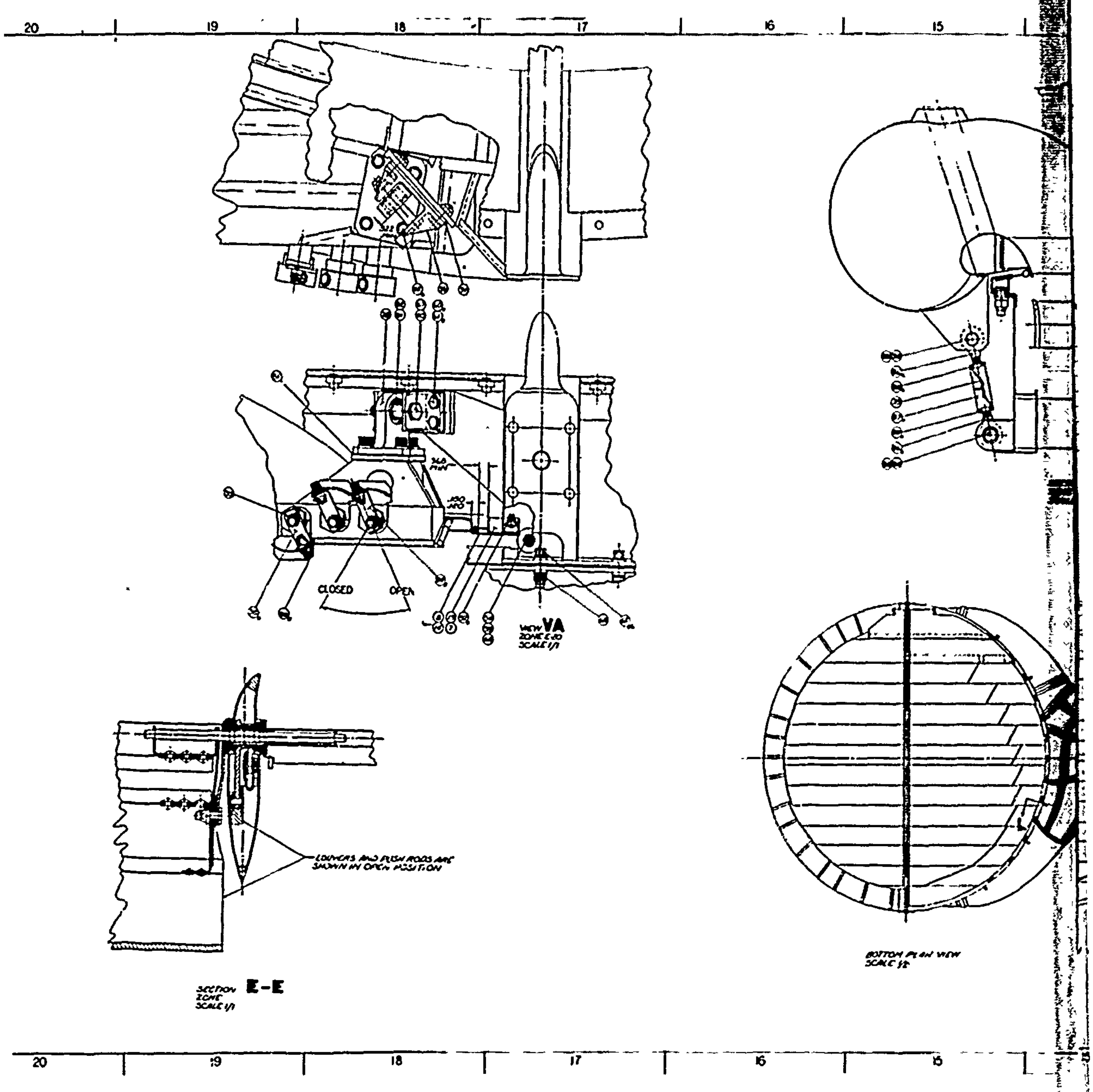
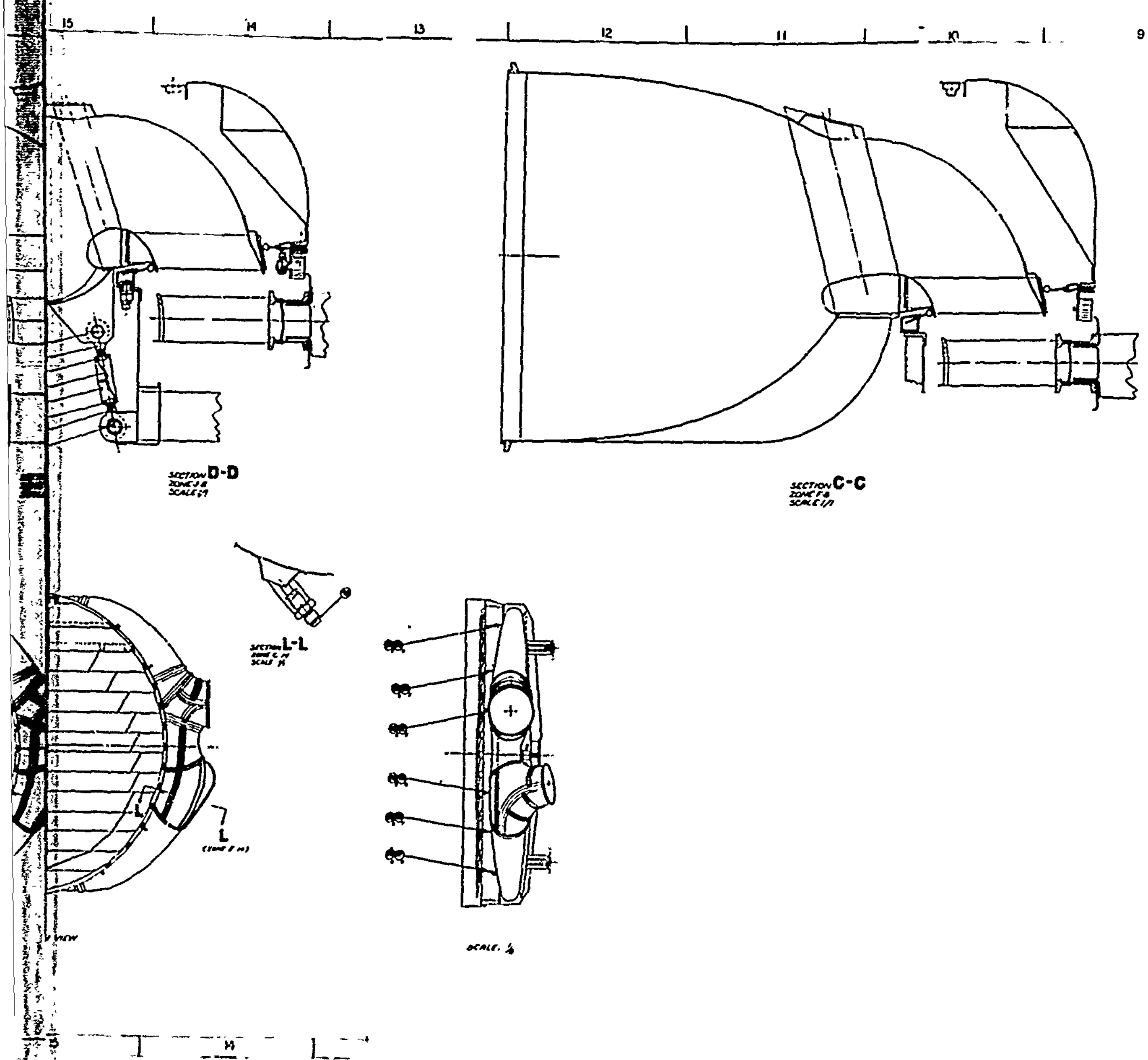


FIGURE 4.1A LIFT FAN BASIC AS
(4012001-942) S

-19



AS N BASIC ASSEMBLY DRAWING (RIGHT)
S 1-942) Sheet 3 of 4

B.

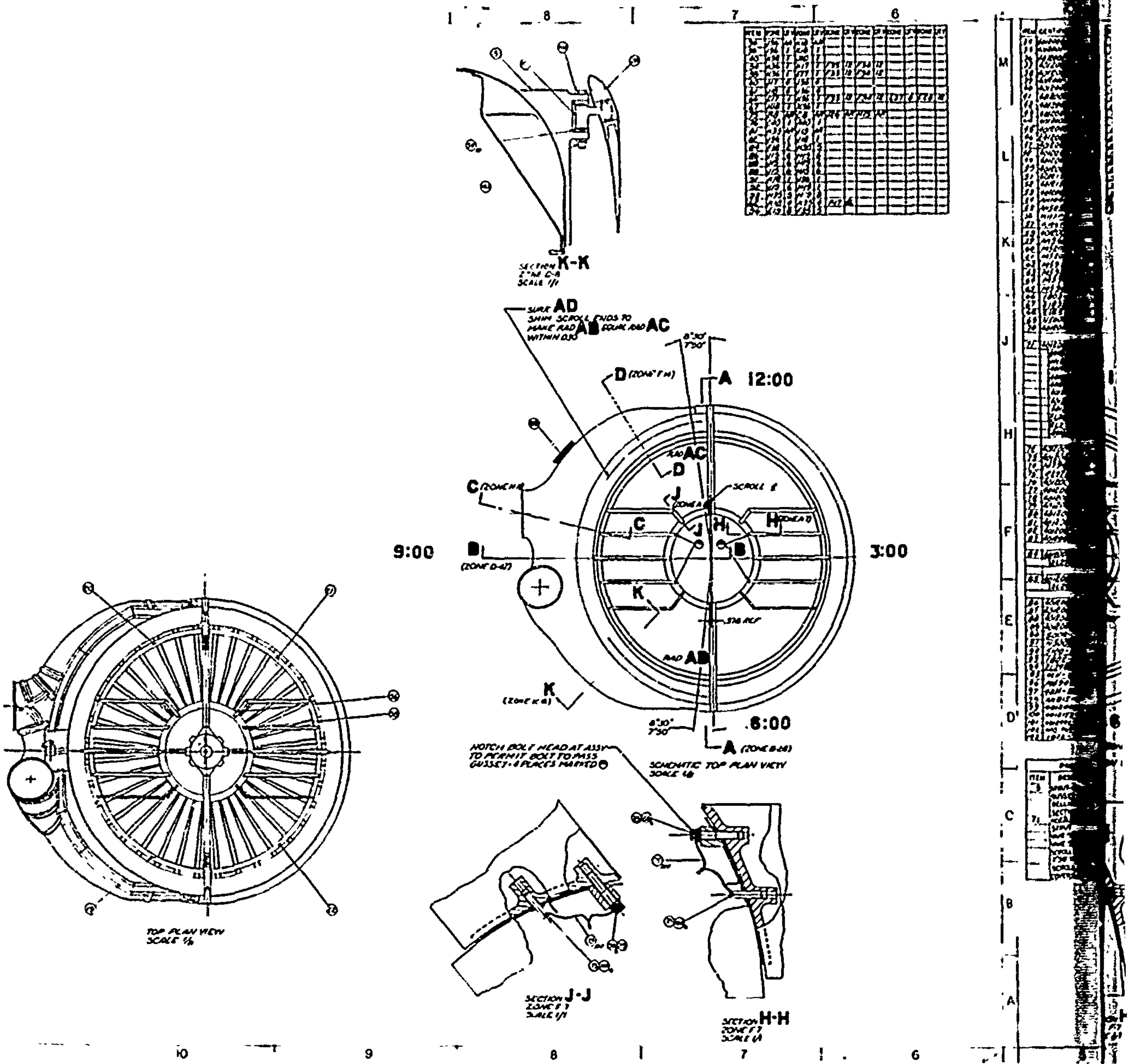
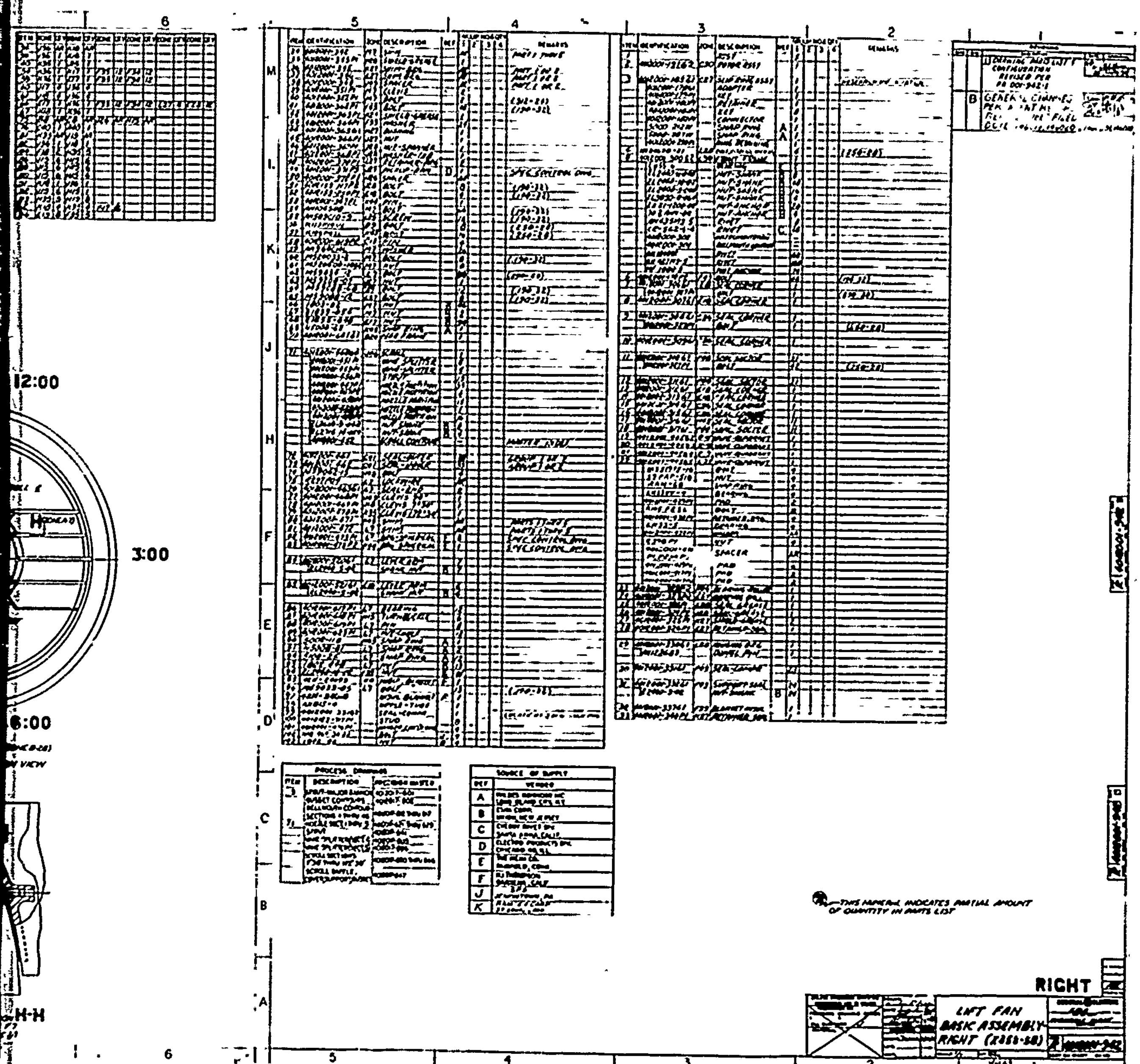


FIGURE 4.1A LIFT FAN BASIC ASSEMBLY
(4012001-942) Sheet 4

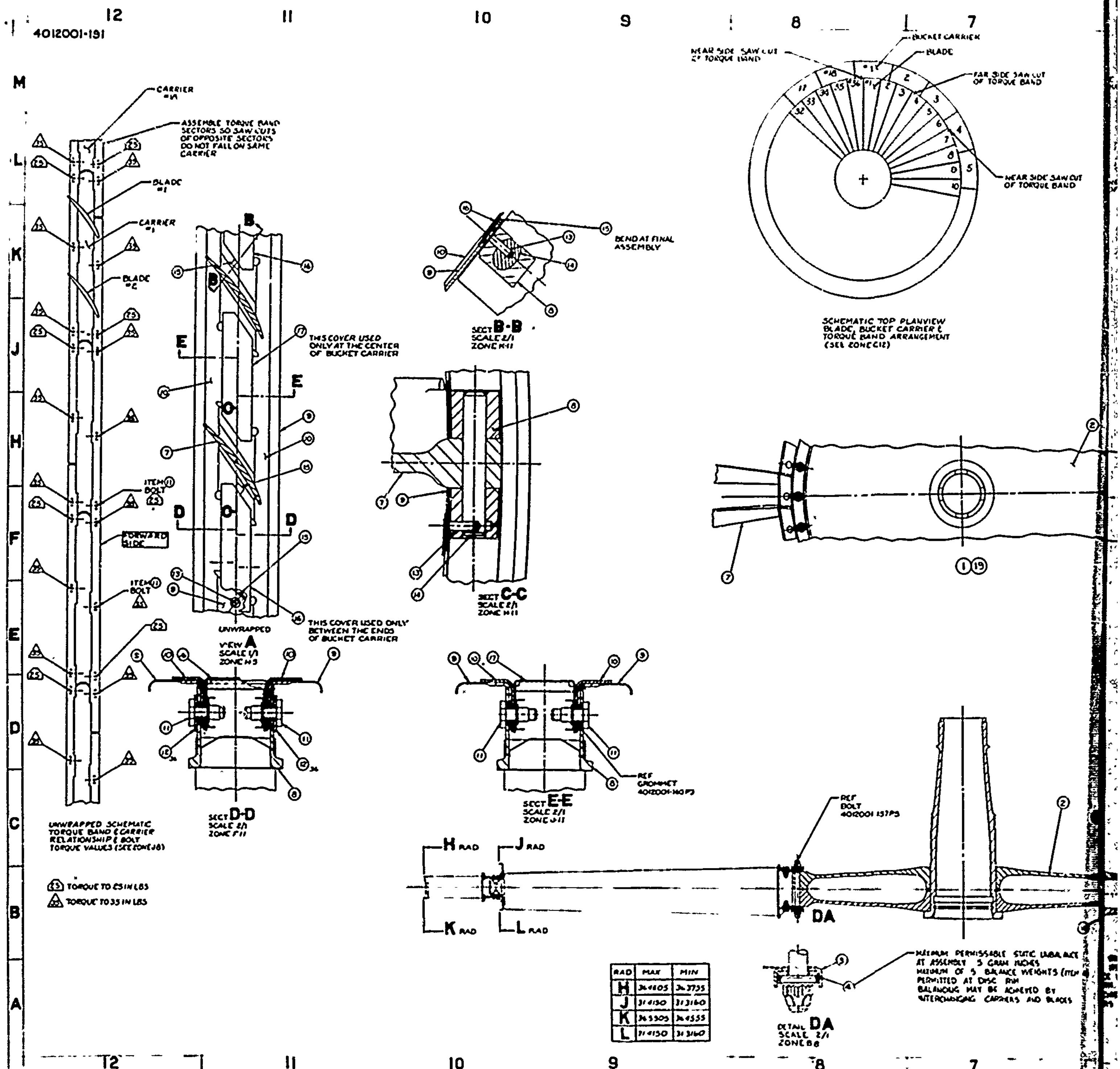
A

50



LIFT FAN BASIC ASSEMBLY DRAWING (RIGHT)
(4012001-942) Sheet 4 of 4

B

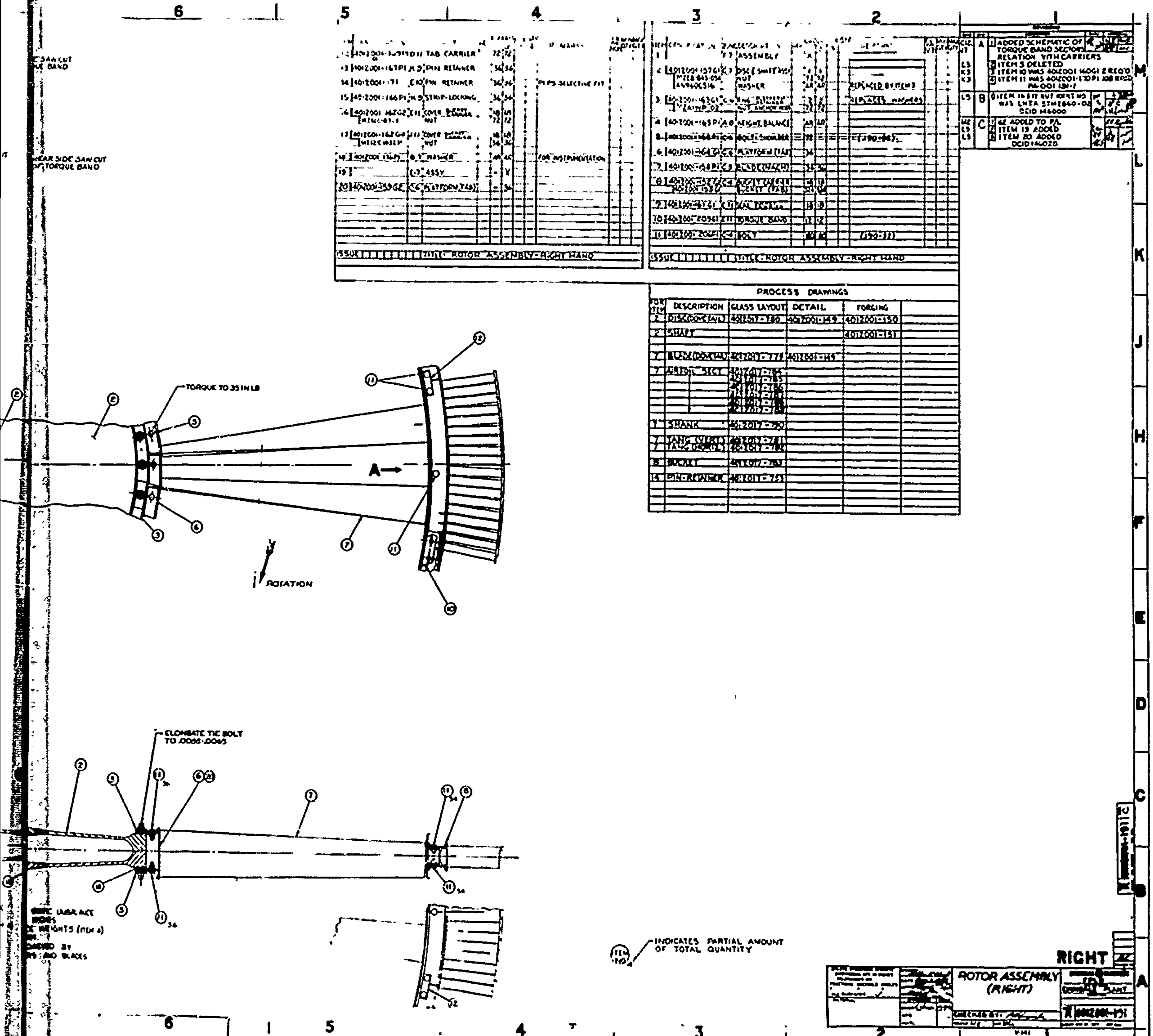


RAD	MAX	MIN
H	36.4105	36.3735
J	31.4130	31.3160
K	36.5305	36.4555
L	31.4150	31.3160

FIGURE 4.2A LIFT FAN ROTOR (4012001-191)

A

21



ROTOR ASSEMBLY DRAWING (RIGHT)
1-191) Sheet 1 of 1

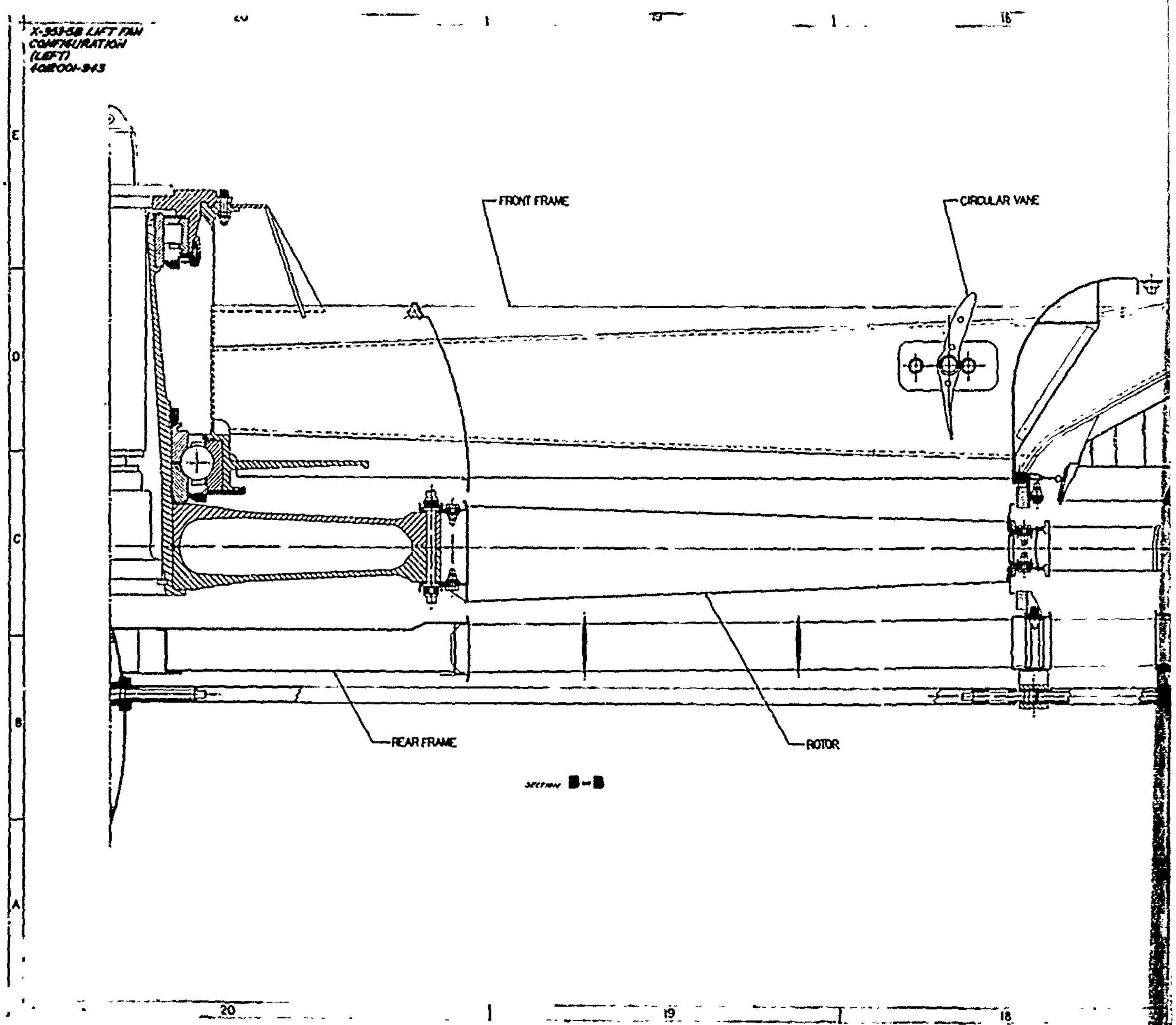
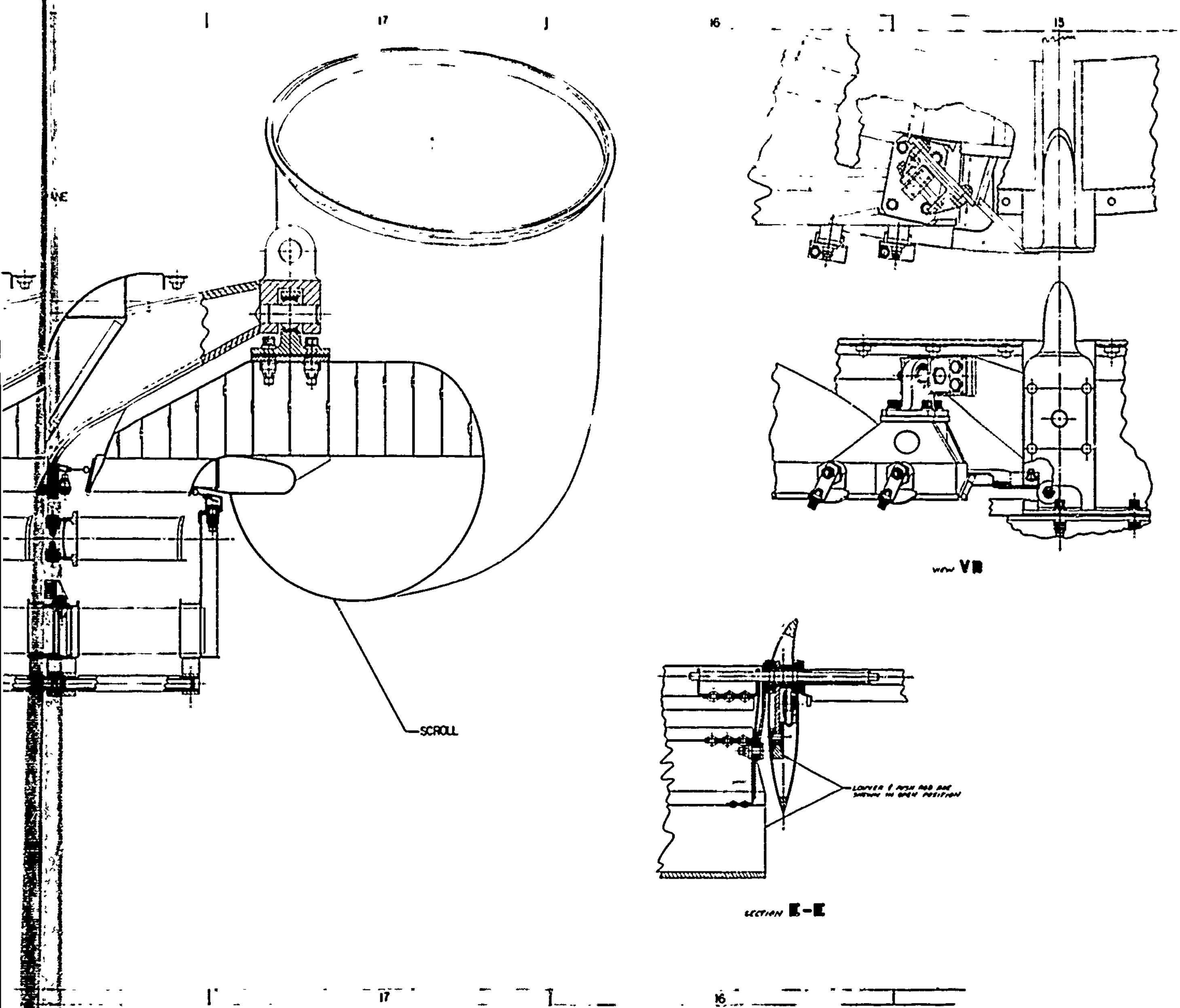


FIGURE 4.2B X353-5B LIFT FAN CO
(4012001-943) Shee



CO LIFT FAN CONFIGURATION (LEFT)
ee(-943) Sheet 1 of 3

B

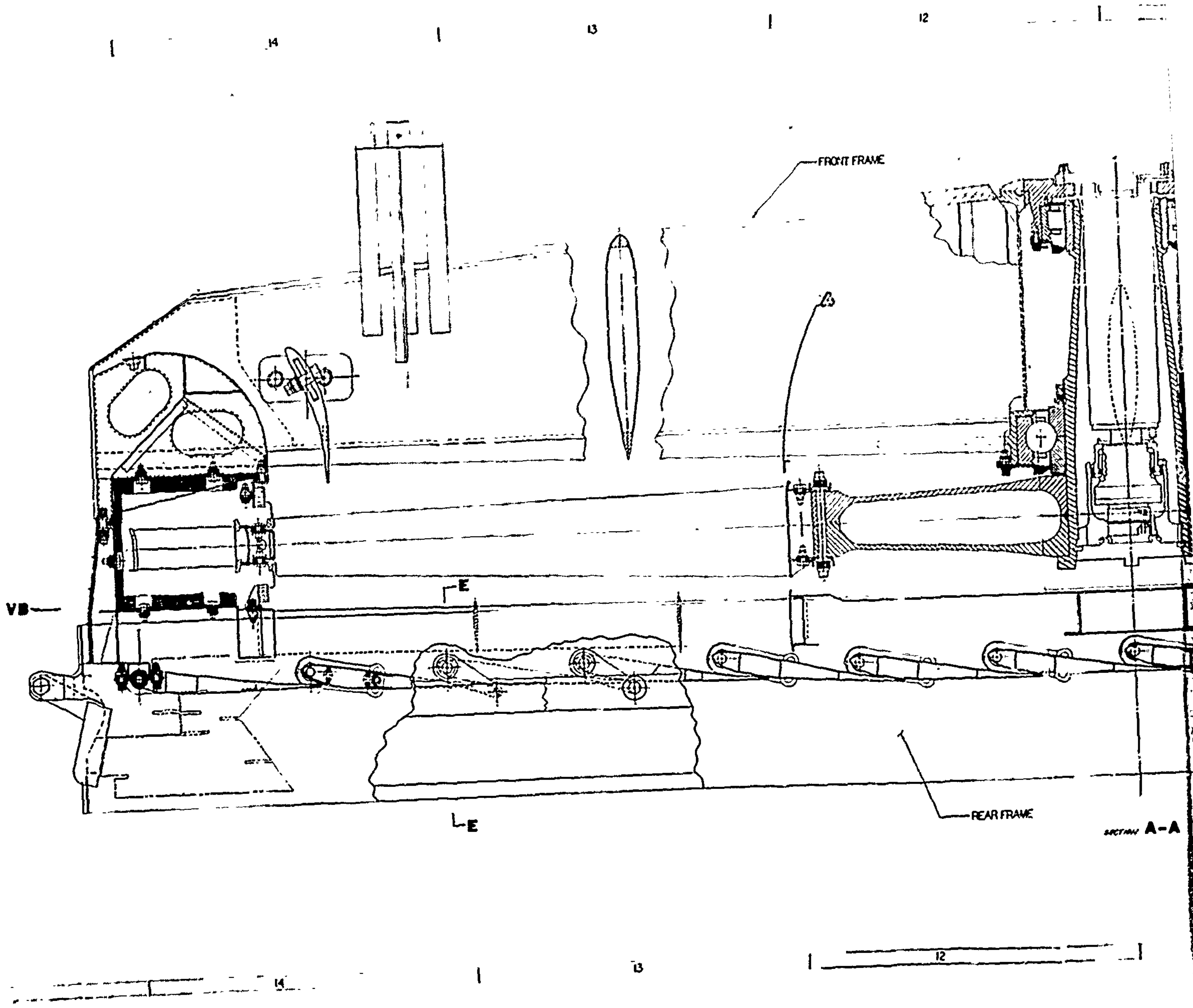
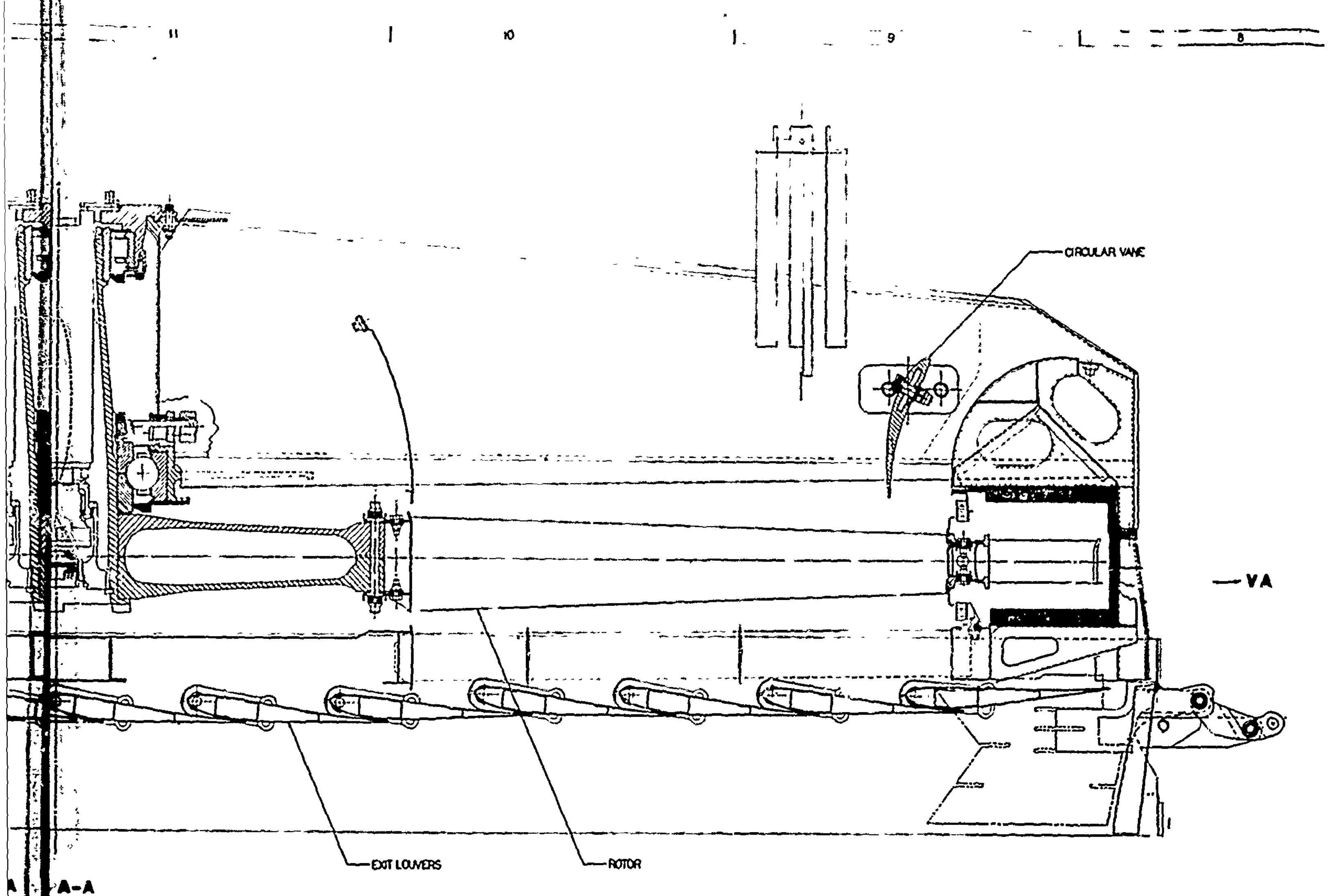


FIGURE 4.2B X353-5B LIFT F
(4012001-943)

A



FALFT FAN CONFIGURATION (LEFT)
43) Sheet 2 of 3

-4.77

B

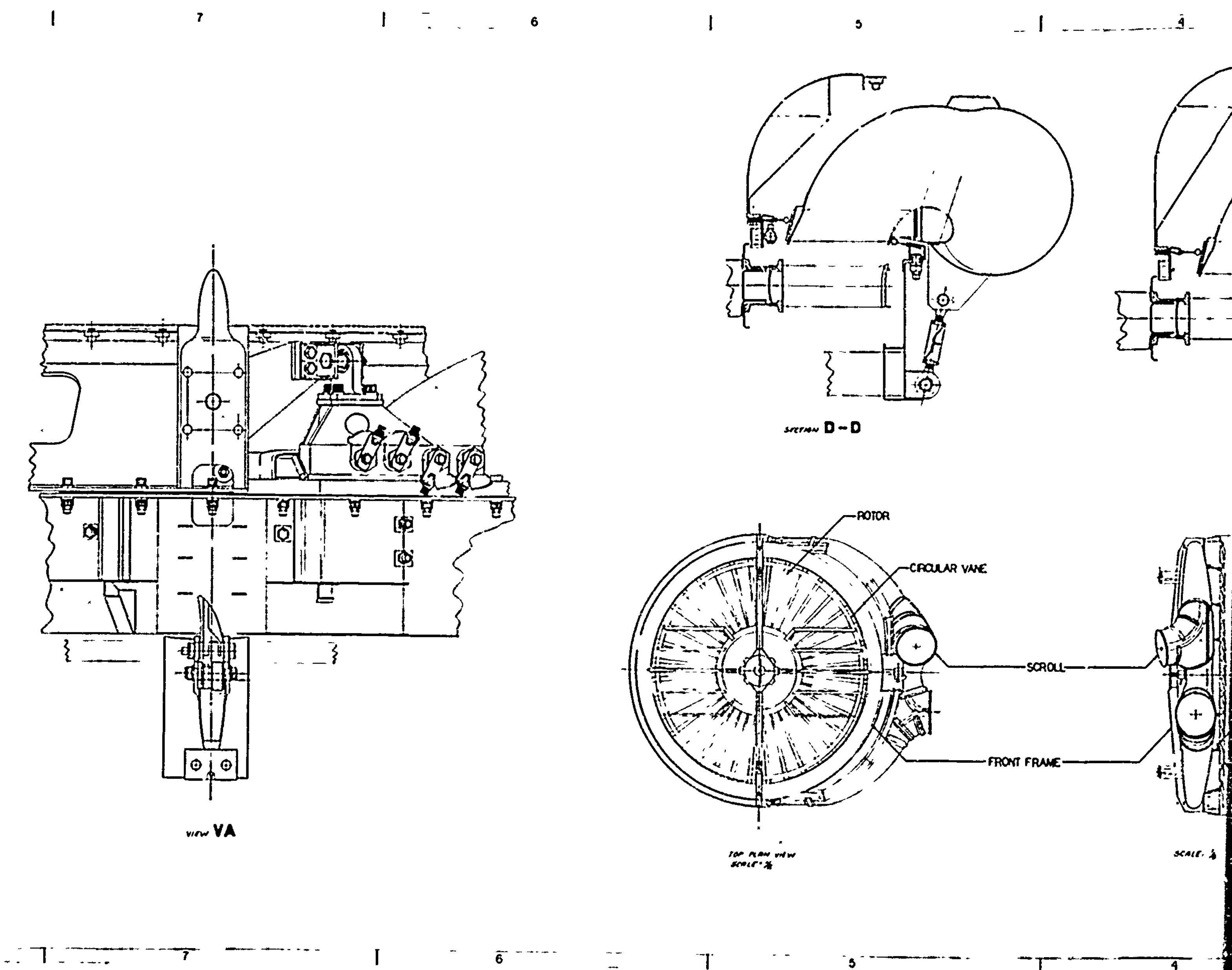
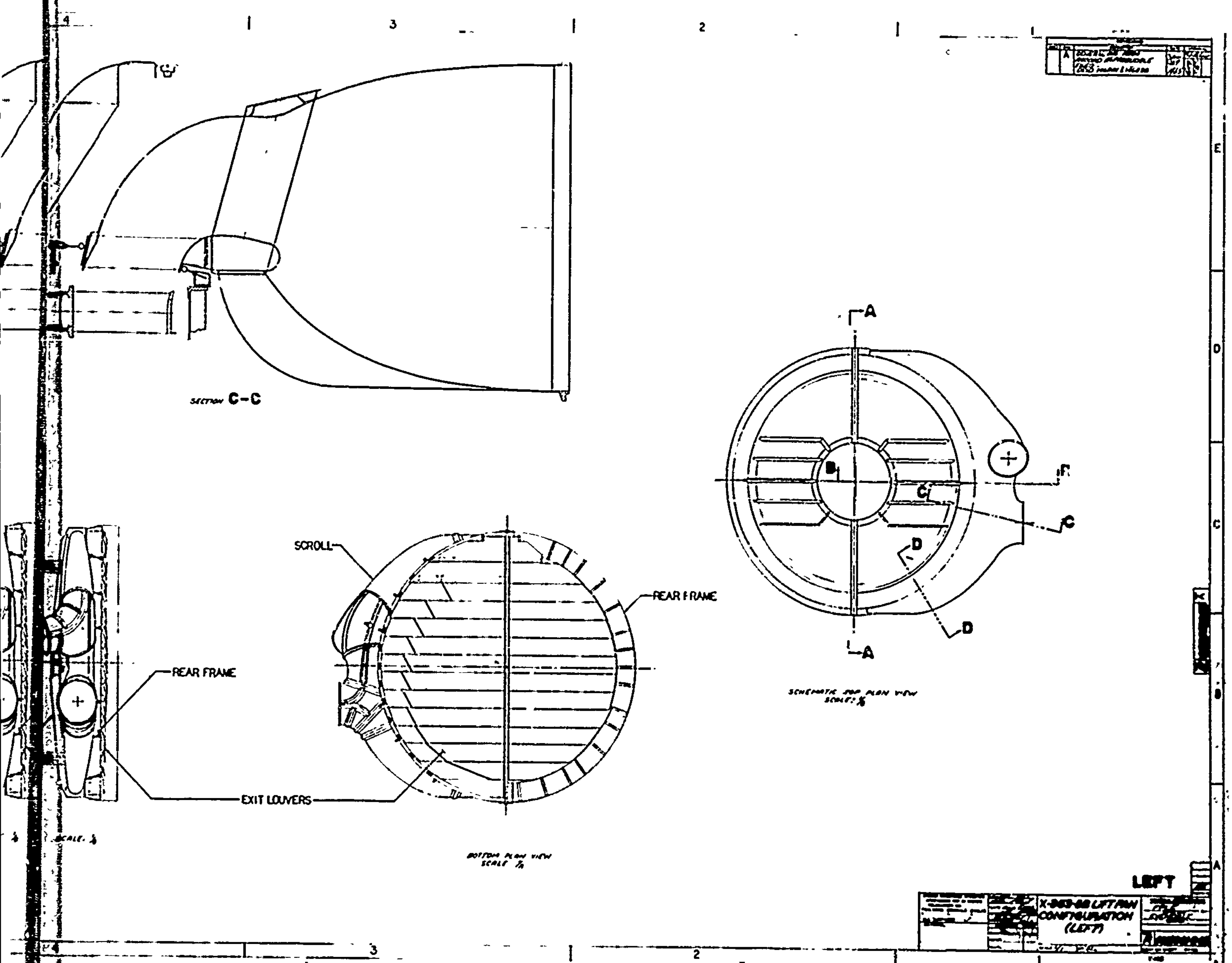


FIGURE 4.2B X353-5B LIFT F
(4012001-943)



F LIFT FAN CONFIGURATION (LEFT)
) 943) Sheet 3 of 3

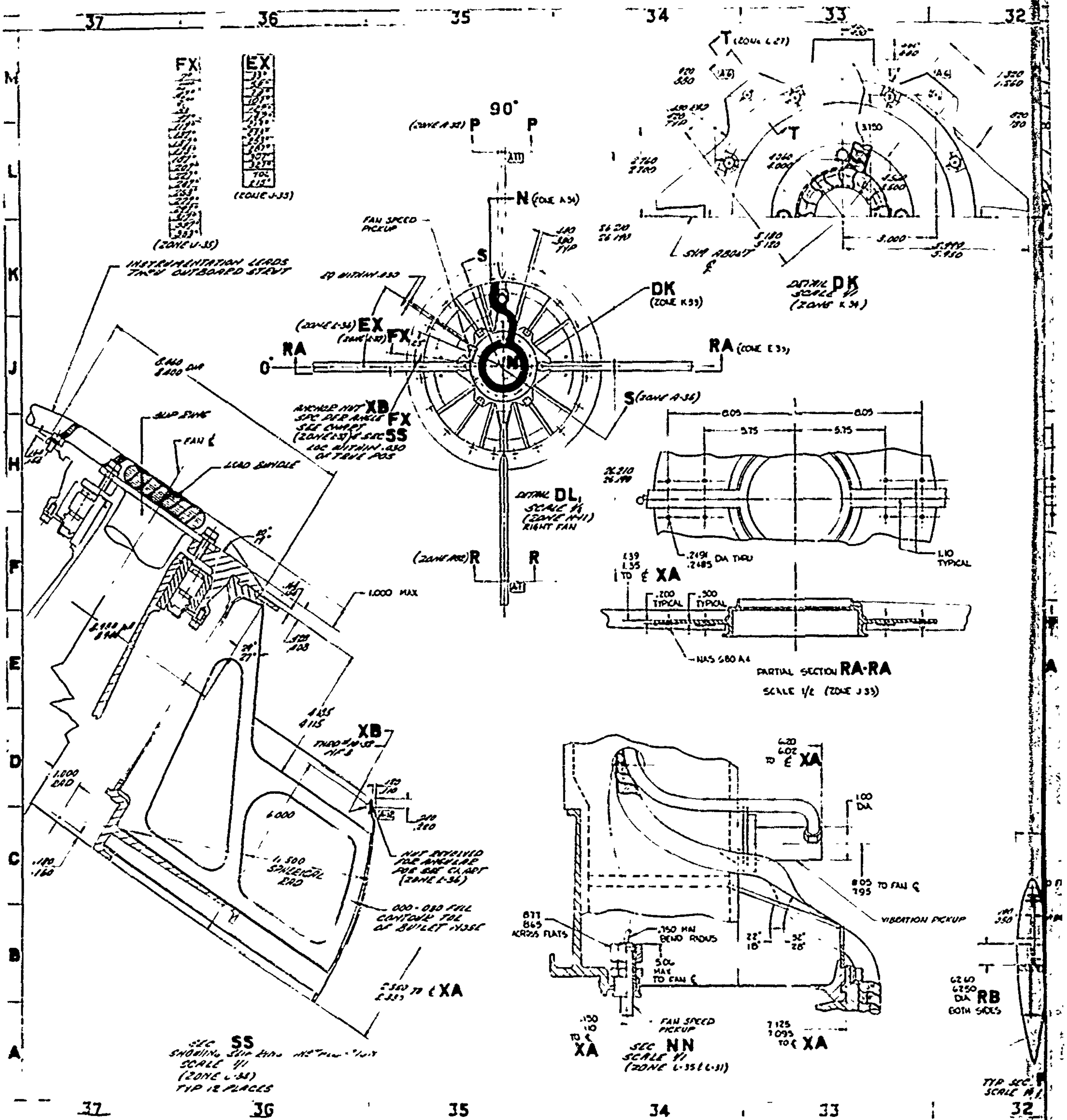
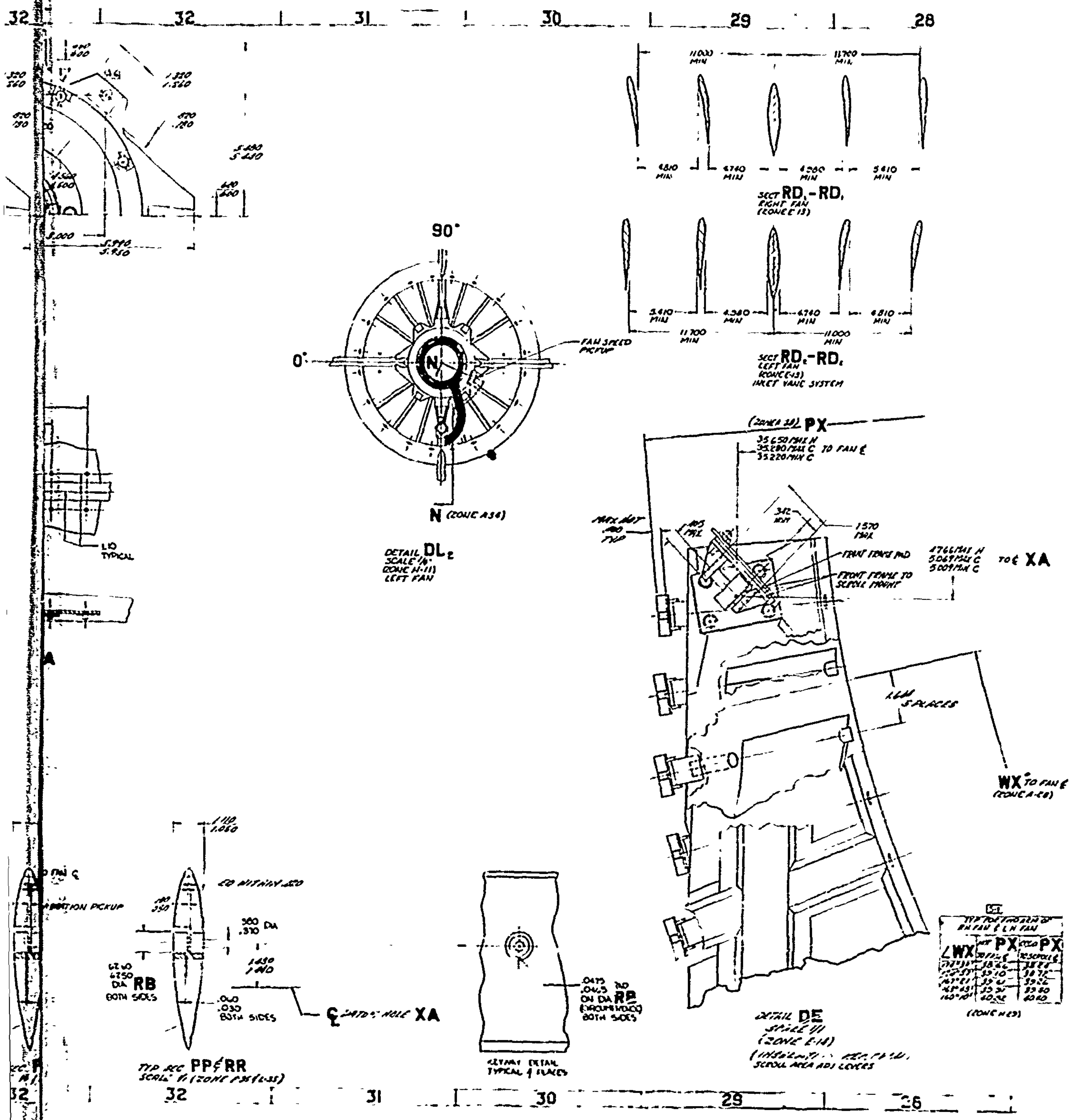


FIGURE 4.2C X353-5B LIFT F[illegible]5
(4012001-911) [illegible]0



X353-5B LIFT FAN INSTALLATION
(4012001-911) Sheet 1 of 4

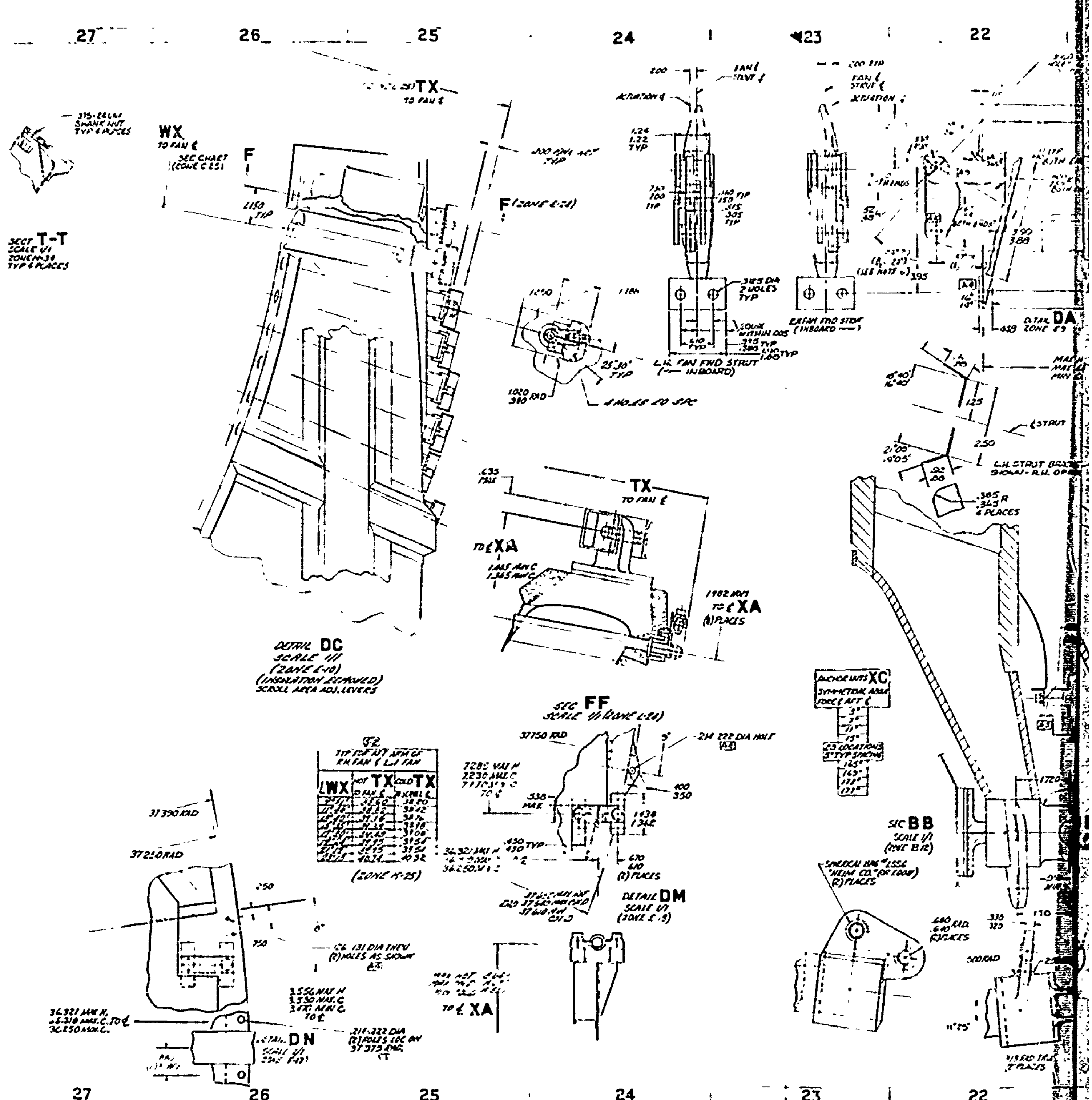
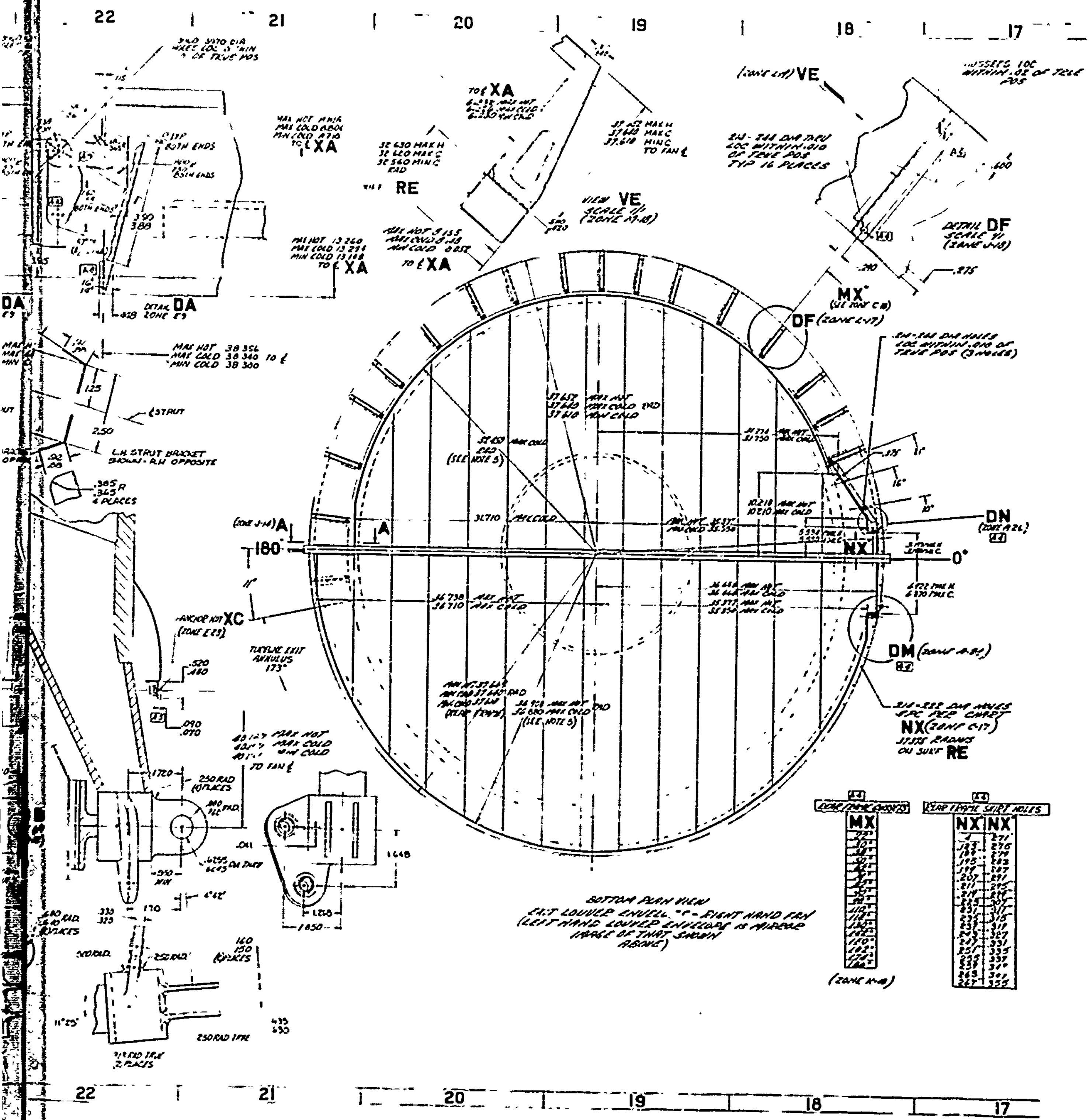


FIGURE 4.2C X353-5B LIFT FAN
(4012001-911) S



B LIFT FAN INSTALLATION
01-911) Sheet 2 of 4

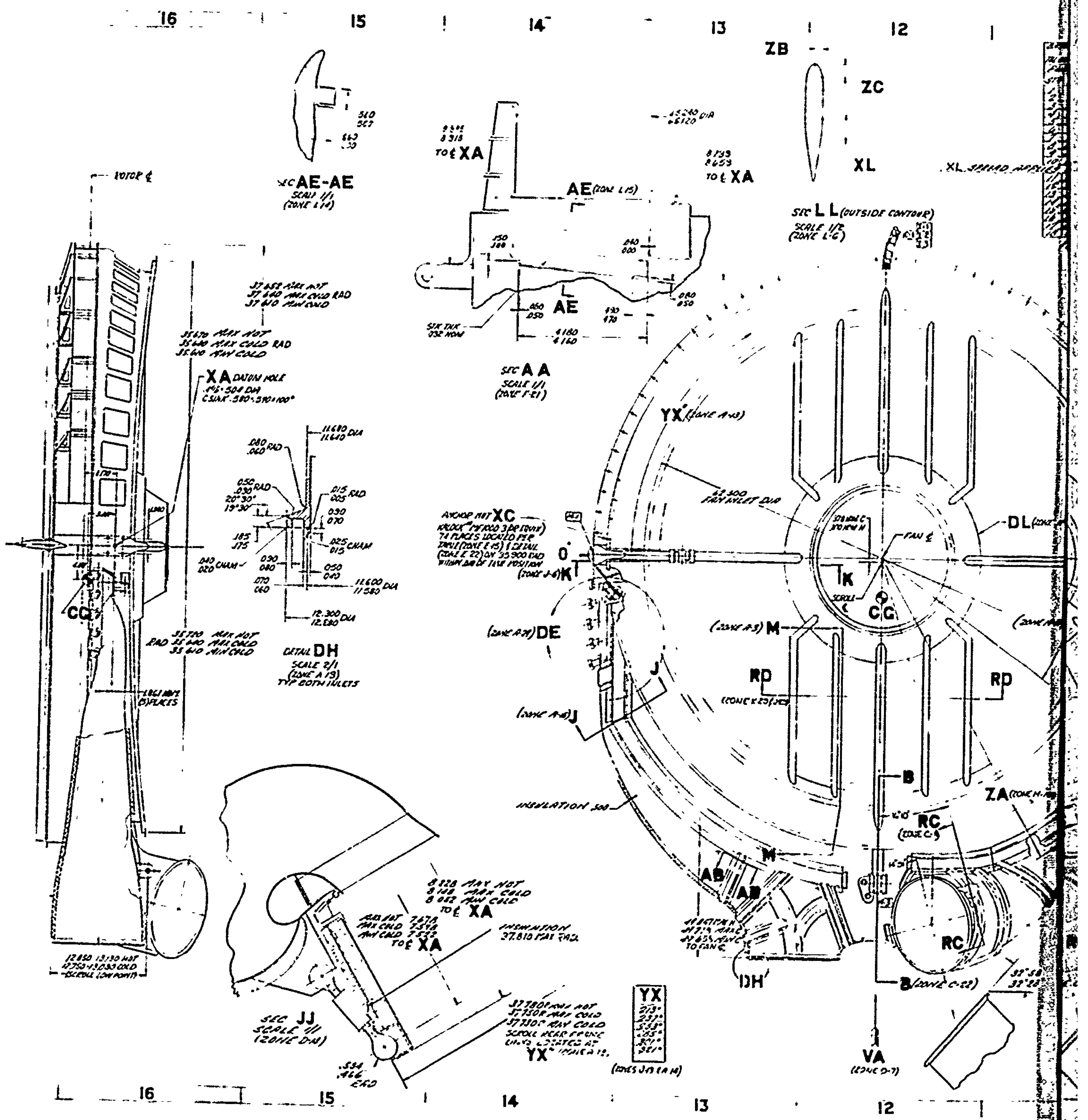
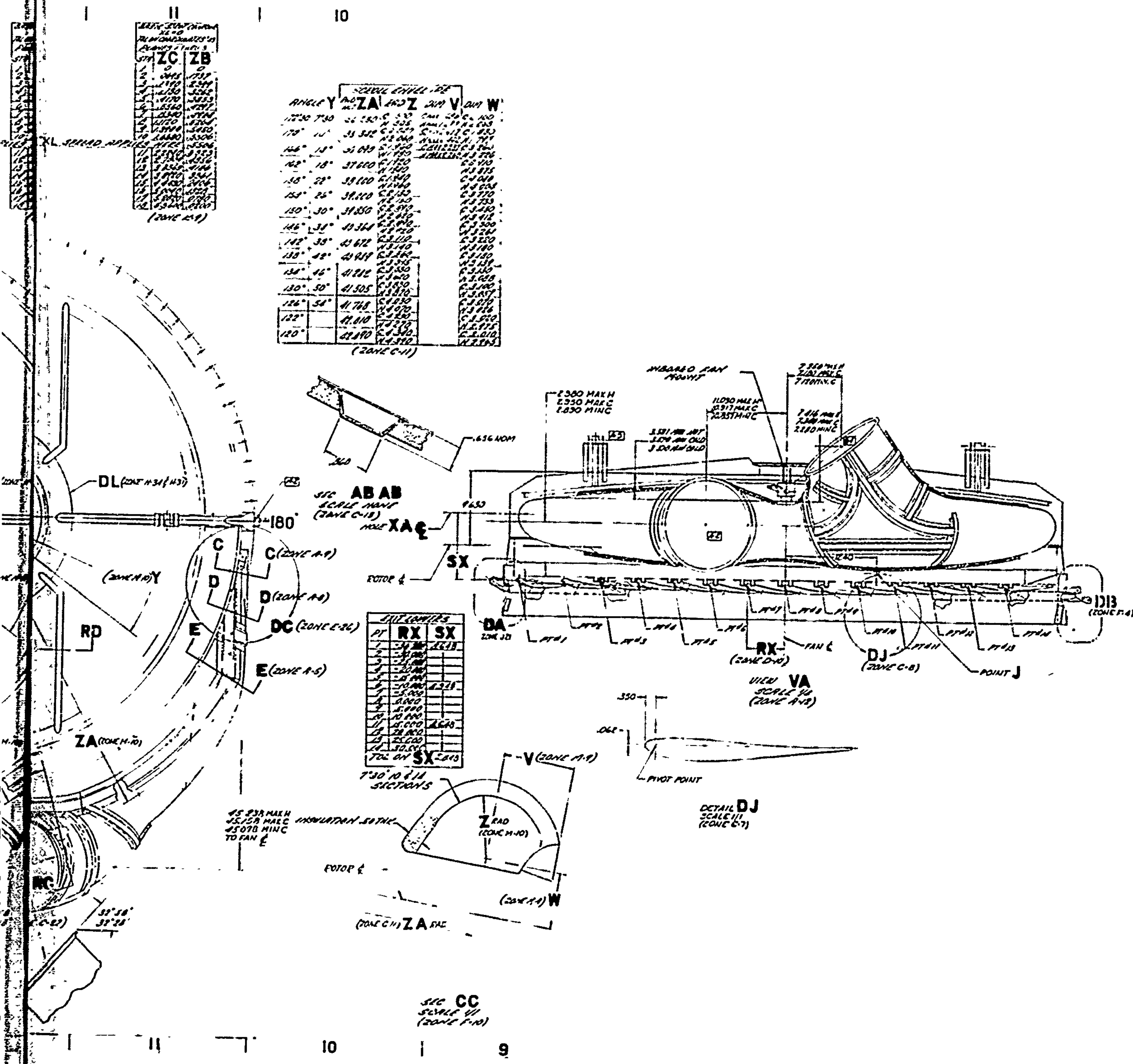


FIGURE 4.2C X353-5B LIFT F
(4012001-911)

A



LIFT FAN INSTALLATION
(…01-911) Sheet 3 of 4

B

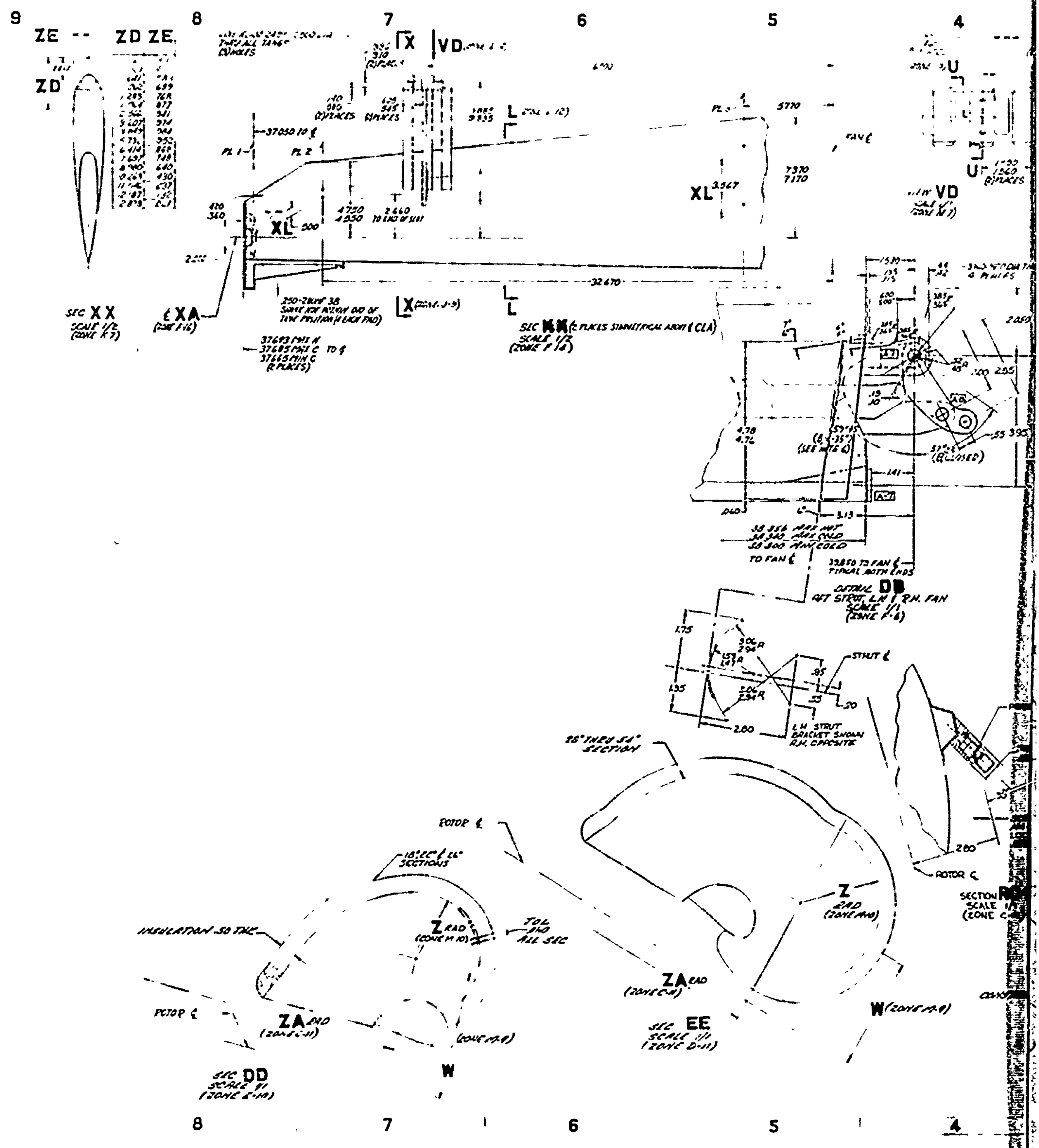
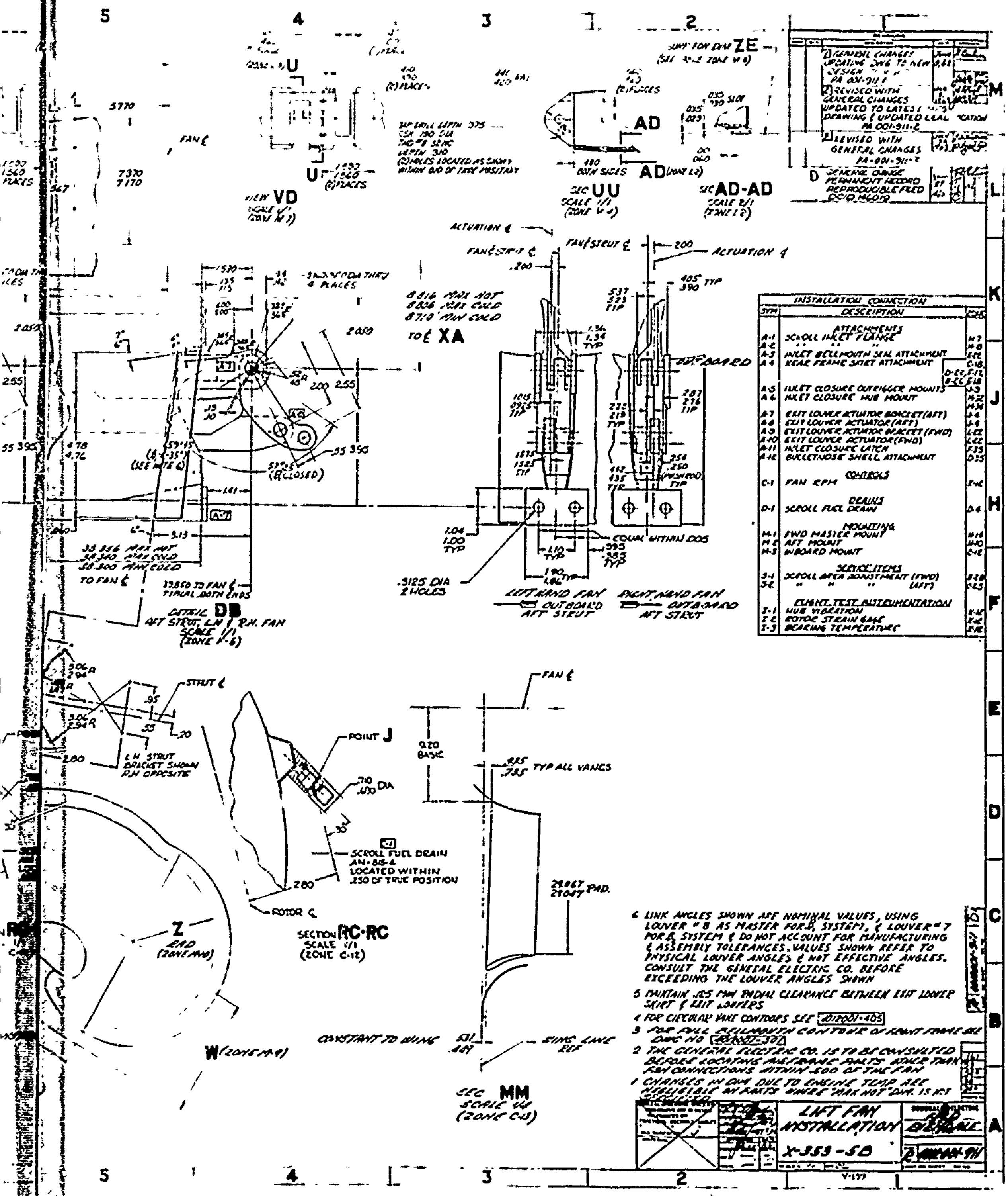


FIGURE 4.2C X353-5B LIFT FAN INSTALLA
(4012001-911) Sheet 4 of 4

A

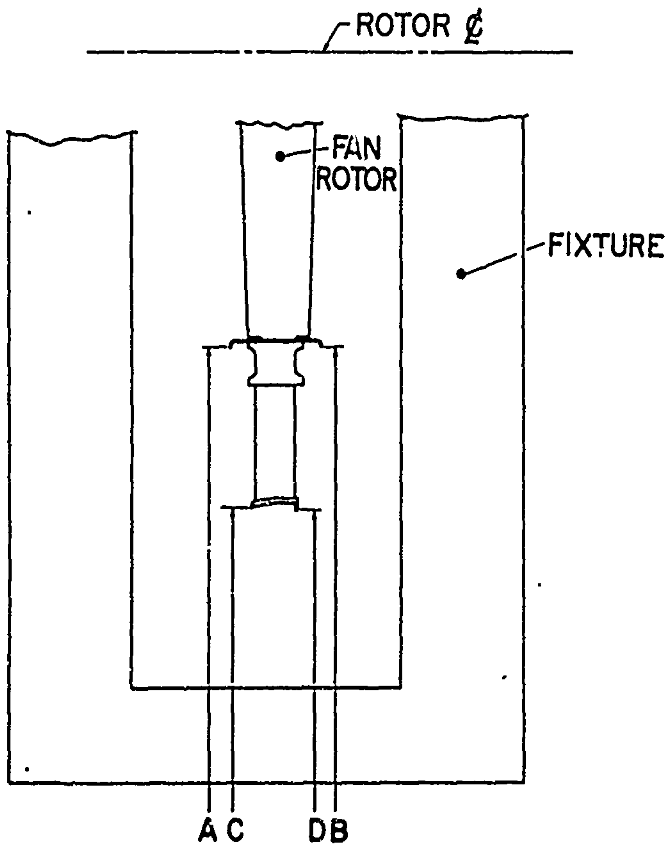


LA 353-5B LIFT FAN INSTALLATION
of 4012001-911) Sheet 4 of 4

B

Bolt #	Length	Torque lb. in.	Bolt #	Length	Torque lb. in.	Bolt #	Length	Torque lb. in.
1.	free ______ elong______	fwd ______ aft ______	13.	free ______ elong______	fwd ______ aft ______	25.	free ______ elong______	fwd ______ aft ______
2.	free ______ elong______	fwd ______ aft ______	14.	free ______ elong______	fwd ______ aft ______	26.	free ______ elong______	fwd ______ aft ______
3.	free ______ elong______	fwd ______ aft ______	15.	free ______ elong______	fwd ______ aft ______	27.	free ______ elong______	fwd ______ aft ______
4.	free ______ elong______	fwd ______ aft ______	16.	free ______ elong______	fwd ______ aft ______	28.	free ______ elong______	fwd ______ aft ______
5.	free ______ elong______	fwd ______ aft ______	17.	free ______ elong______	fwd ______ aft ______	29.	free ______ elong______	fwd ______ aft ______
6.	free ______ elong______	fwd ______ aft ______	18.	free ______ elong______	fwd ______ aft ______	30.	free ______ elong______	fwd ______ aft ______
7.	free ______ elong______	fwd ______ aft ______	19.	free ______ elong______	fwd ______ aft ______	31.	free ______ elong______	fwd ______ aft ______
8.	free ______ elong______	fwd ______ aft ______	20.	free ______ elong______	fwd ______ aft ______	32.	free ______ elong______	fwd ______ aft ______
9.	free ______ elong______	fwd ______ aft ______	21.	free ______ elong______	fwd ______ aft ______	33.	free ______ elong______	fwd ______ aft ______
10.	free ______ elong______	fwd ______ aft ______	22.	free ______ elong______	fwd ______ aft ______	34.	free ______ elong______	fwd ______ aft ______
11.	free ______ elong______	fwd ______ aft ______	23.	free ______ elong______	fwd ______ aft ______	35.	free ______ elong______	fwd ______ aft ______
12.	free ______ elong______	fwd ______ aft ______	24.	free ______ elong______	fwd ______ aft ______	36.	free ______ elong______	fwd ______ aft ______

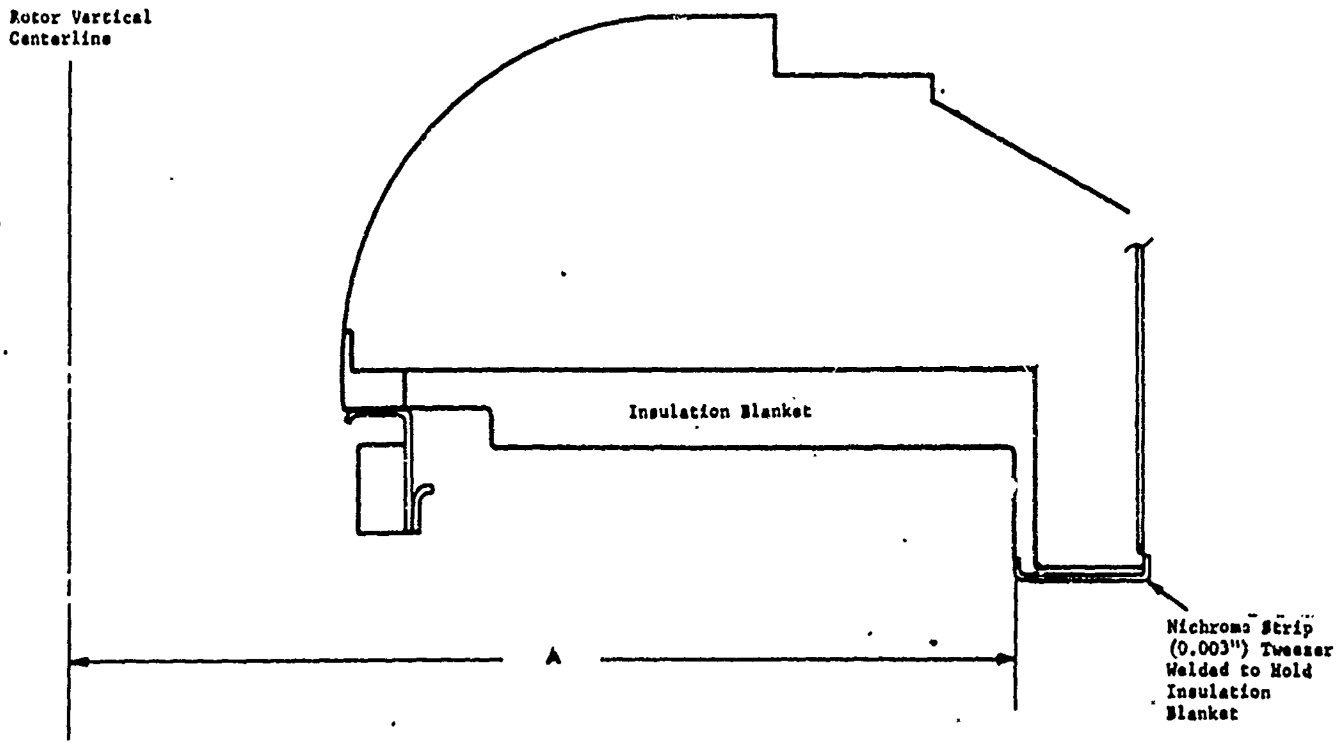
FIGURE 4.3 - ROTOR TIE BOLT TORQUING PROCEDURE.



	F.I.R. B/P	F.I.R. Actual	Max. Radius from Rotor ℄ B/P	Max. Radius from Rotor ℄ Actual
A.	.070 Max		31.375 / 31.360	
B.	.070 Max		31.375 / 31.360	
C.	.070 Max		36.400 / 36.350	
D.	.070 Max		36.400 / 36.375	

(NOTE: Mark Location of Maximum Radius with Dykem)

Figure 4.4 Rotor Air Seal and Tip Seal Inspection

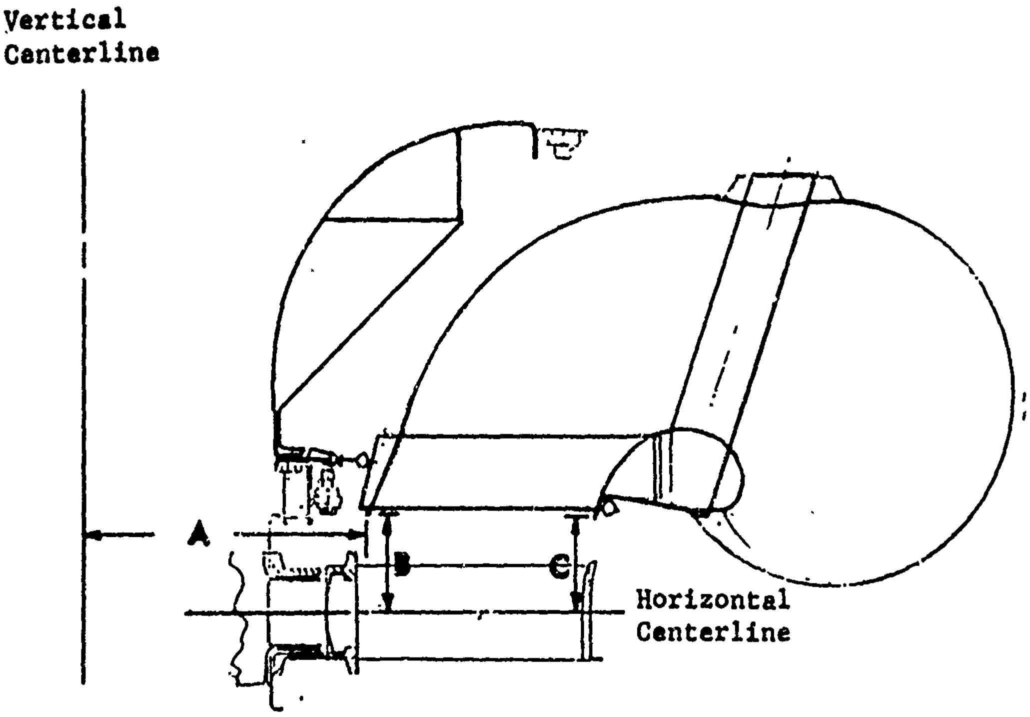


Dimension A -- Rotor Vertical Centerline to I.D. of Insulation Blanket

B/P 36.700

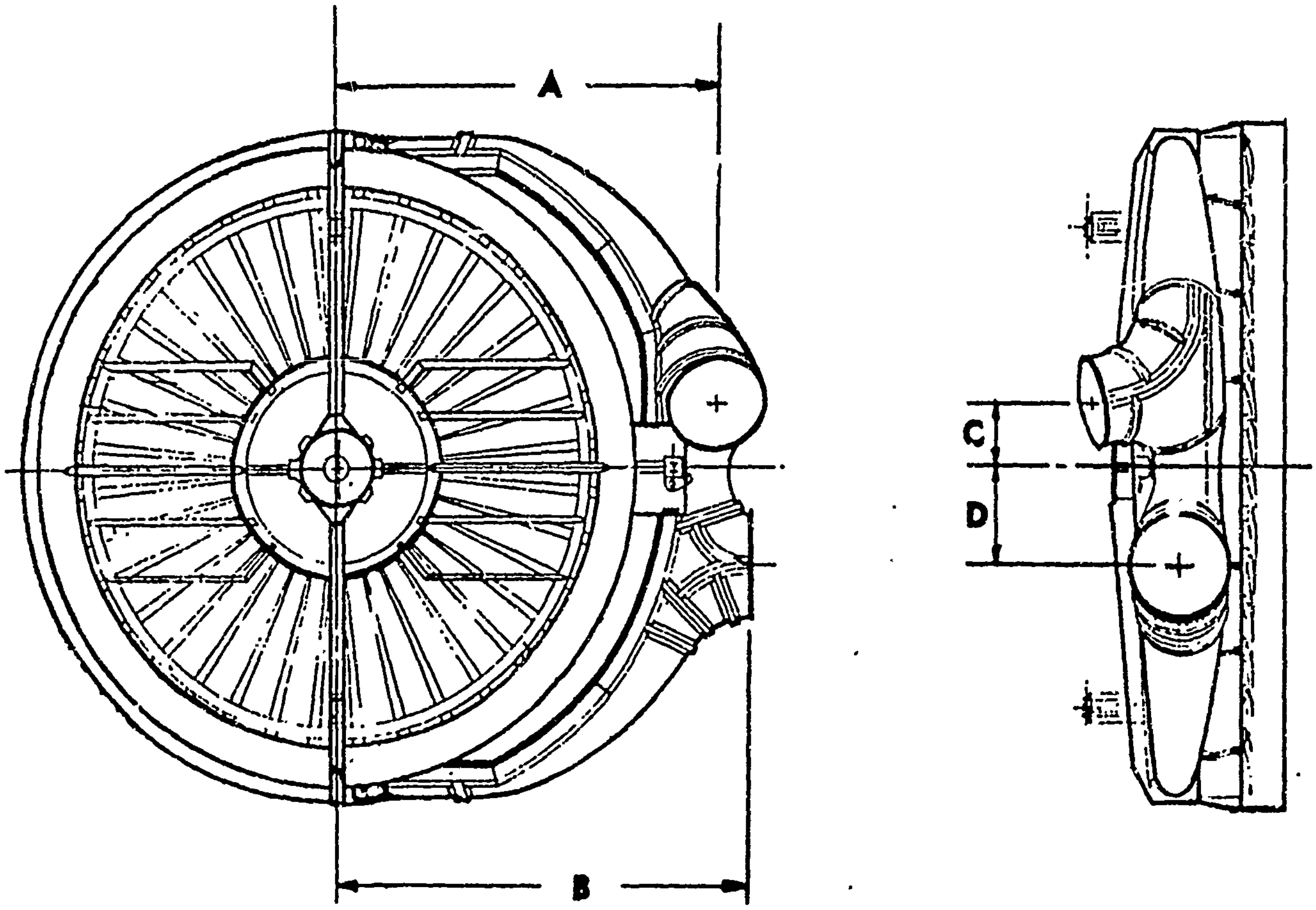
Actual ______

Figure 4.5 Front Frame Insulation Blanket Inspection



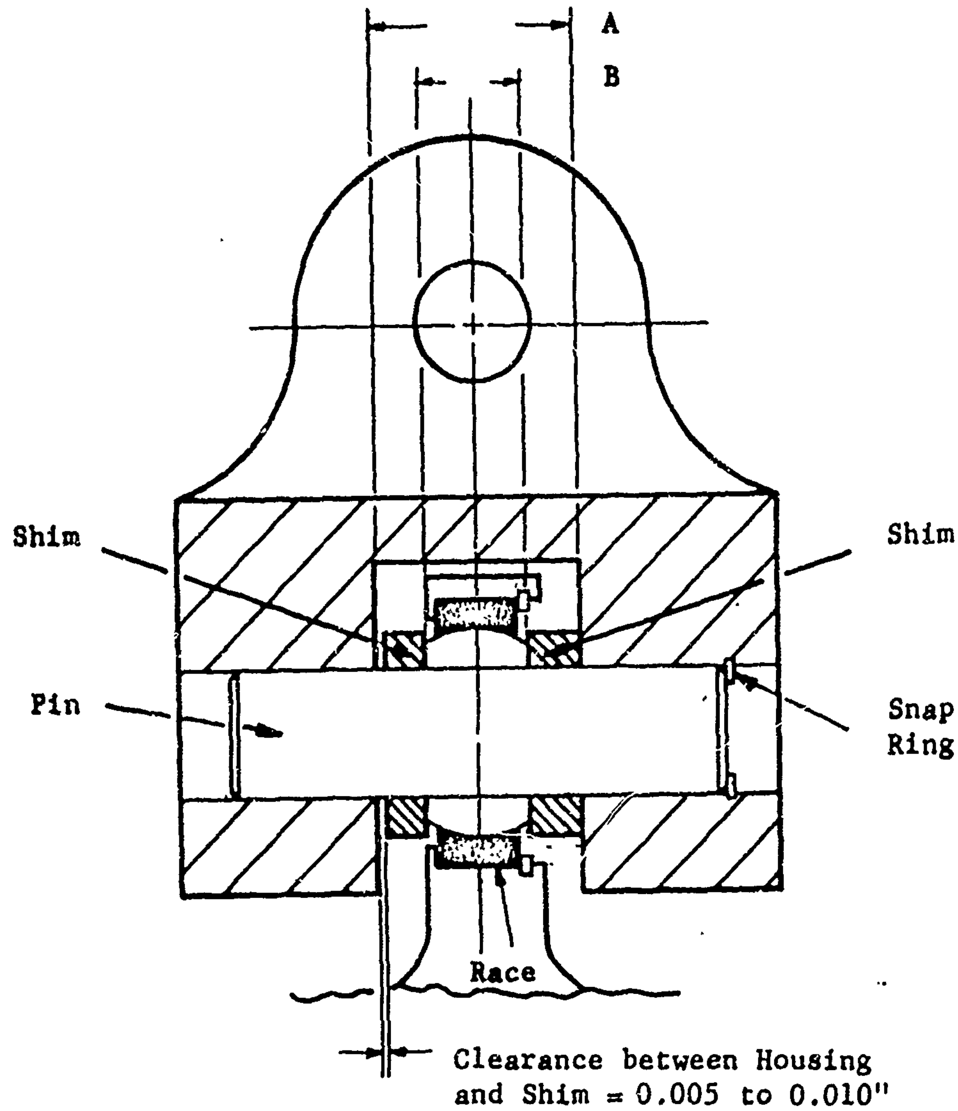
		B/P		Actual
A.	Rotor Vertical Centerline to Scroll Nozzle Lip	Max. ______	Max. ______	
		Min. ______	Min. ______	
B.	Rotor Horizontal Centerline to Scroll Nozzle Lip	Max. ______	Max. ______	
		Min. ______	Min. ______	
C.	Rotor Horizontal Centerline to Scroll Nozzle Lip	Max. ______	Max. ______	
		Min. ______	Min. ______	

Figure 4.6 Inspection and Adjustment of Scroll to Front Frame



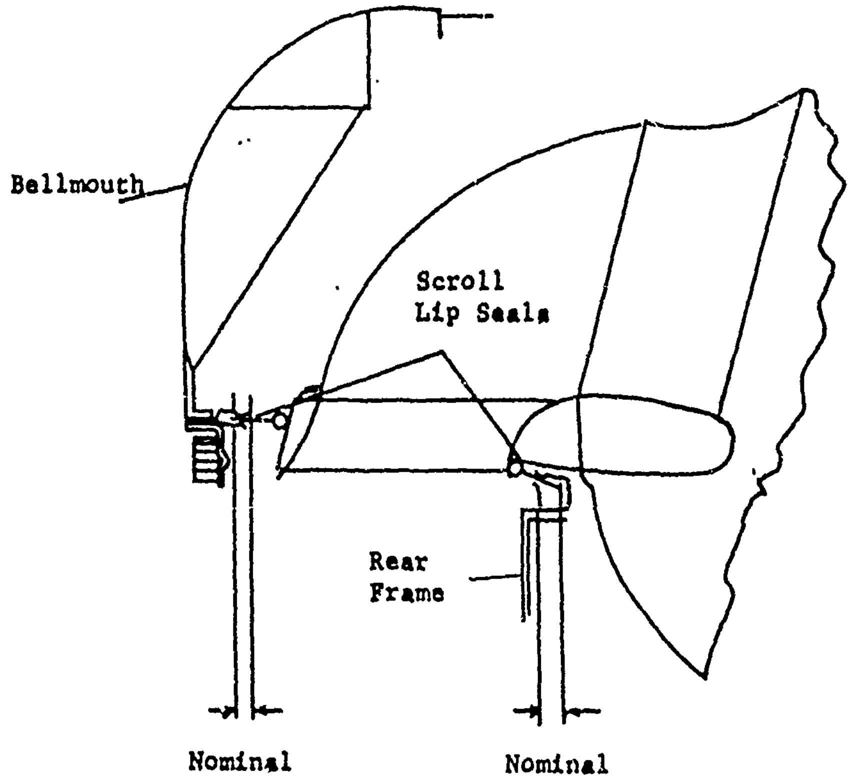
		B/P	Actual
Dimension	A	45.158 45.098	______
	B	49.718 49.658	______
	C	7.180 7.120	______
	D	10.917 10.857	______

Figure 4.7 Inspection of Scroll to Front Frame

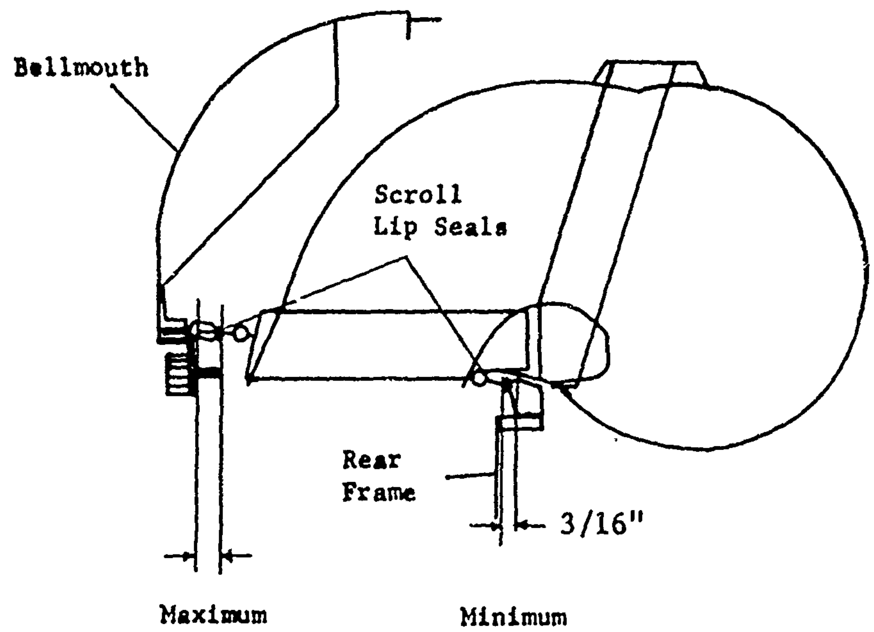


1. Measure Width of Slot "A" ________
2. Measure Width of Uniball "B" ________
3. Subtract "B" from "A" to obtain Difference ________
4. Subtract 0.010" to Provide Clearance ________
5. Divide by 2 to obtain Shim Thickness ________

Figure 4.8 Inspection and Adjustment of Scroll Center Mount Unibal Slot

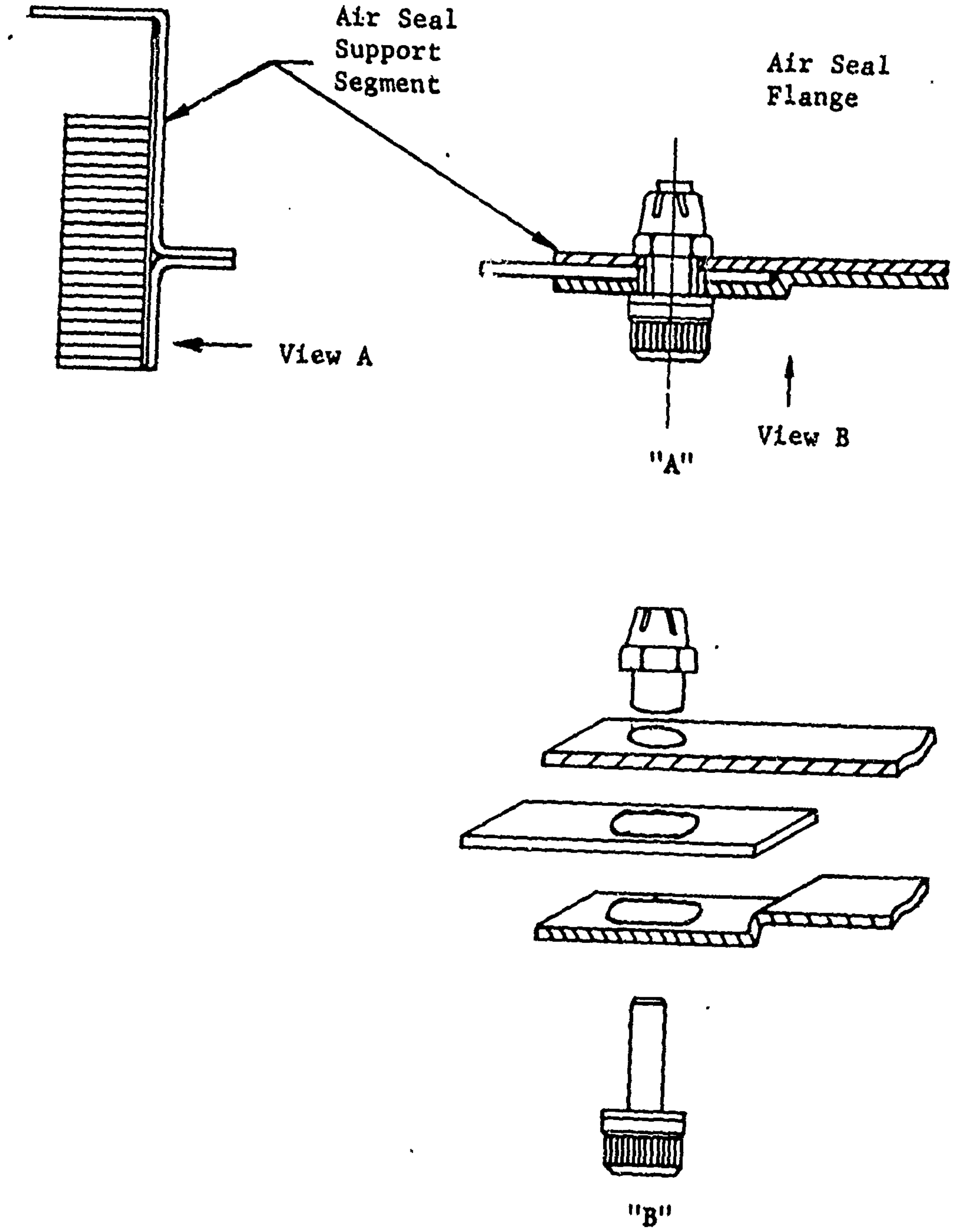


Lip Seal Overlap at Center of Scroll



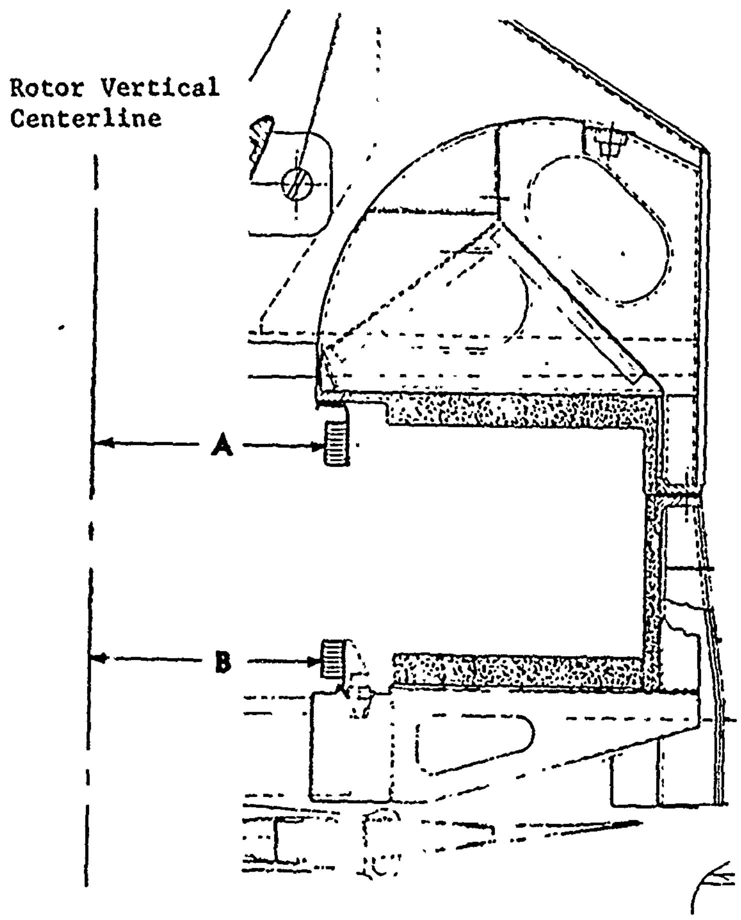
Lip Seal Overlap at Scroll Ends

Figure 4.9 Inspection and Adjustment of Scroll Seal Overlap



Holes at the End of the Air Seal Segments are Elongated.

Figure 4.10 Honeycomb Air Seal Attachment



Top Seal Dimension A		Bottom Seal Dimension B	
(1) Record Dimension A from Figure 4.4	________	(1) Record Dimension B from Figure 4.4	________
(2) Add .085" Nominal for Air Seal Clearance	________	(2) Add .145" Nominal for Air Seal Clearance	________
(3) Desired Radius (Sum of Item 1 and 2)	________	(3) Desired Radius (Sum of Item 1 and 2)	________
(4) Grind Radius ± .010"	________	(4) Grind Radius ± .010"	________
(5) Inspect Dimension A above*	________	(5) Inspect Dimension B above*	________

*Note: Mark Location of Minimum Radius with Dykem.

Figure 4.11 Honeycomb Seal Grinding Instructions and Inspection

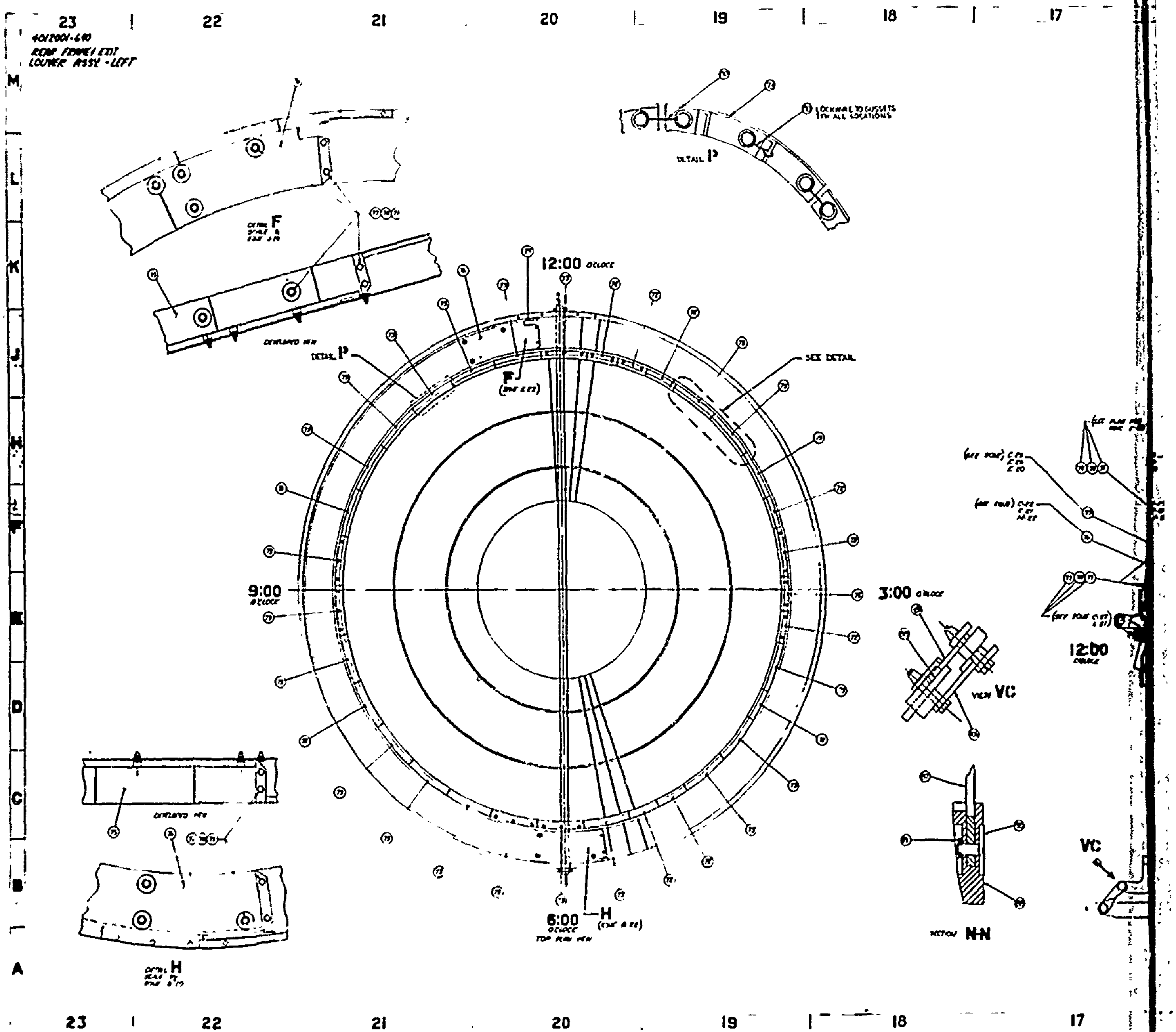
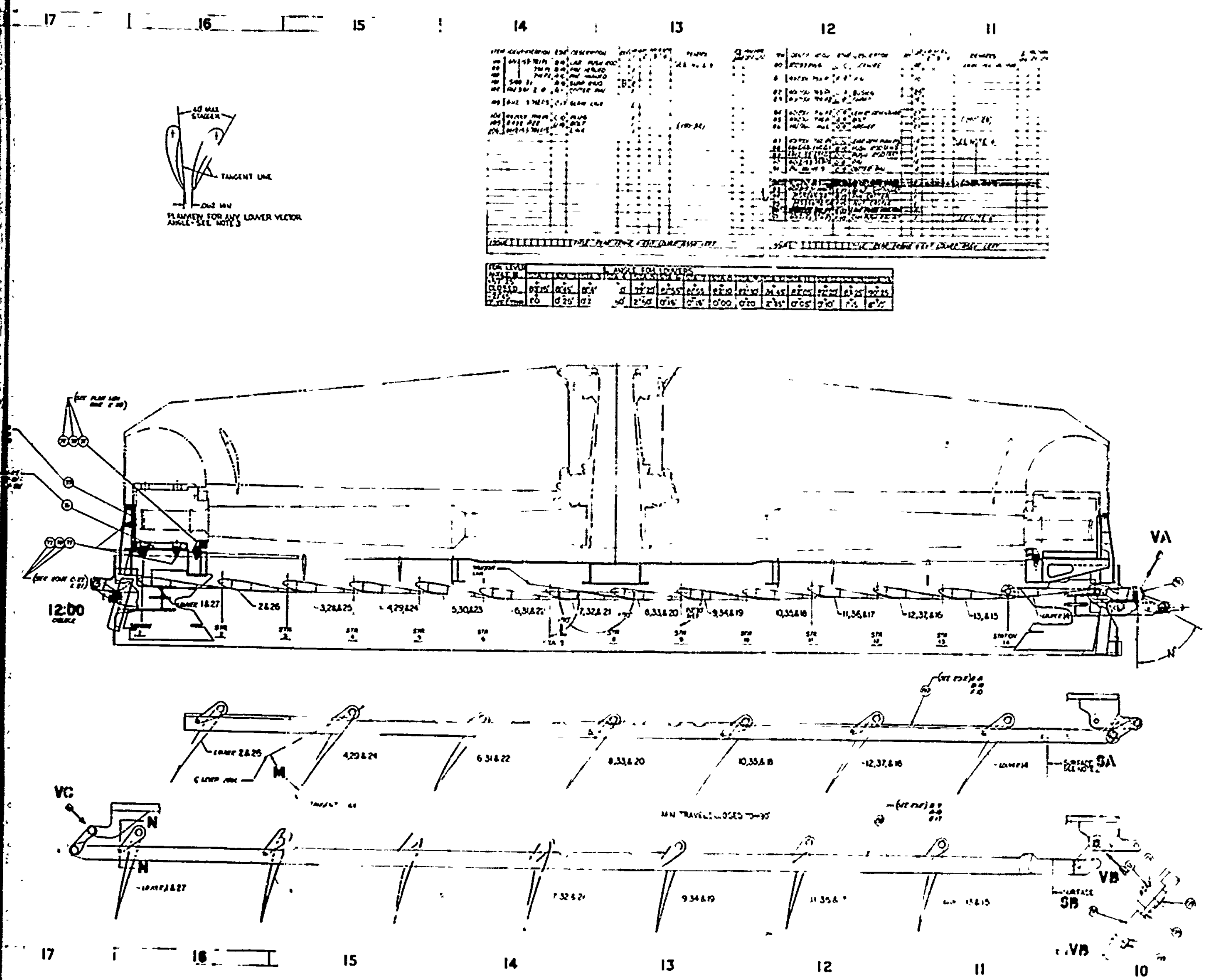


FIGURE 4.12 REAR FR
(401200



REAR FRAME ASSEMBLY DRAWING (LEFT)
(4012001-640) Sheet 1 of 2

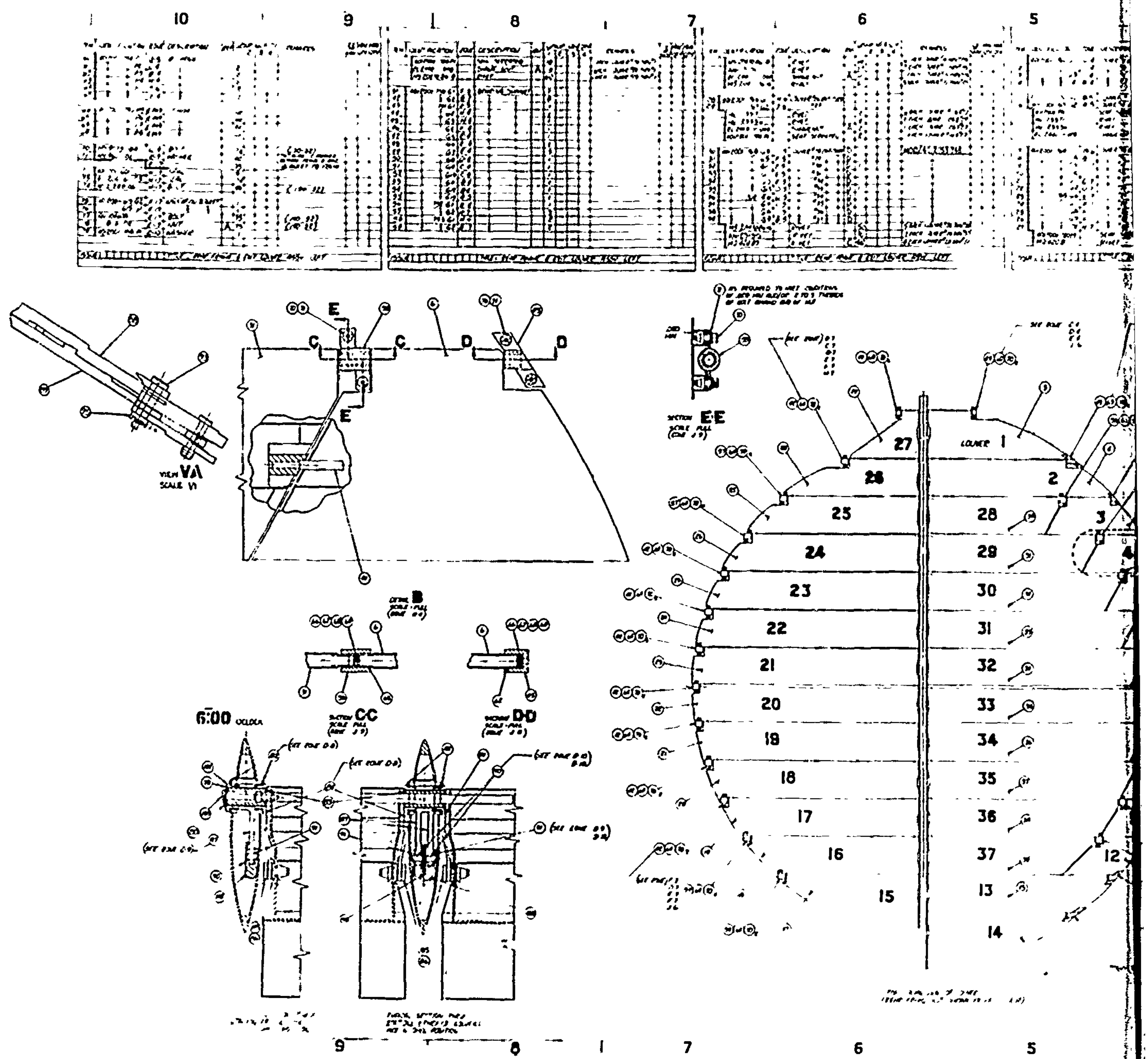
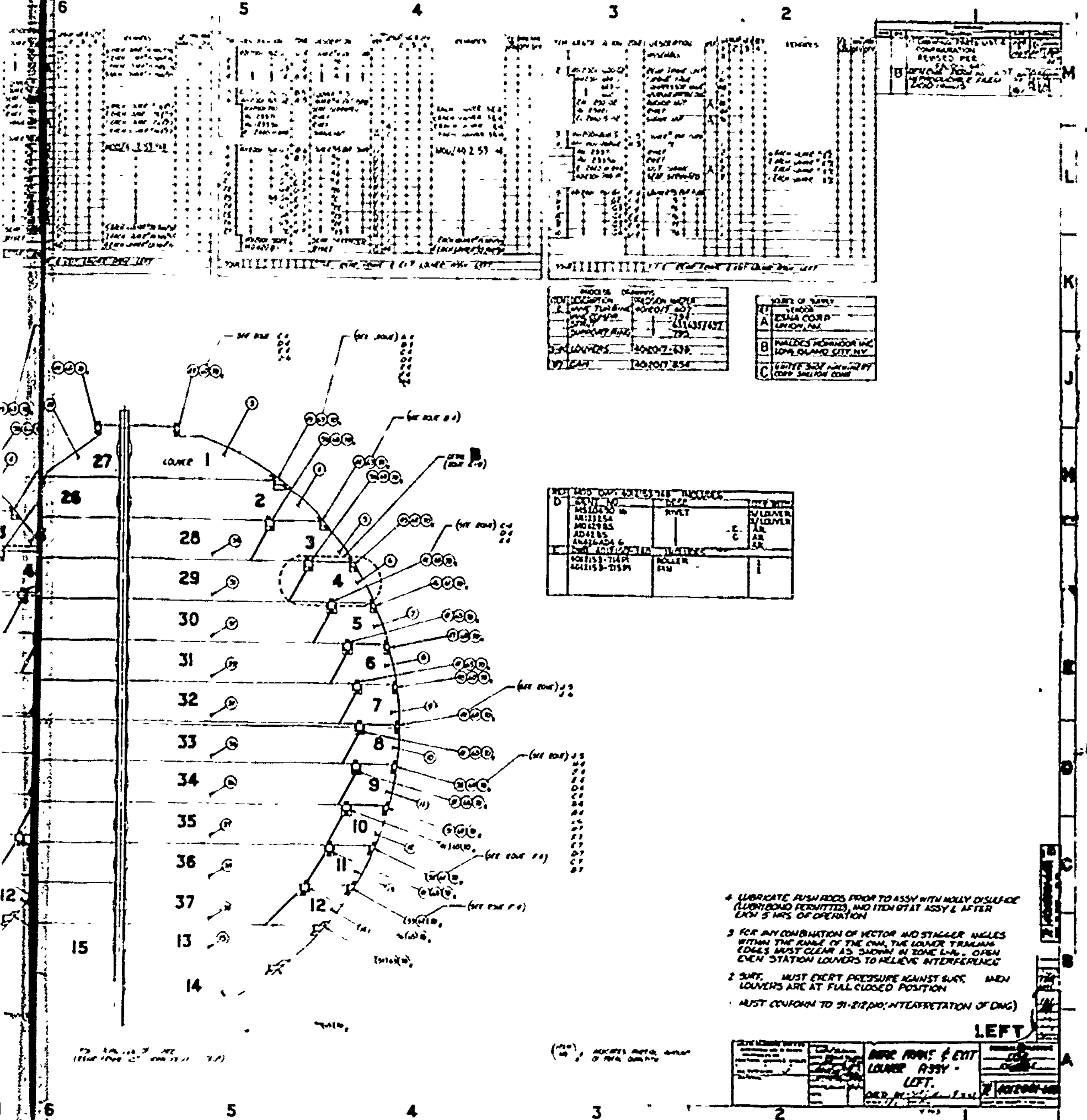


FIGURE 4.12 REAR FRAME ASSEMBLY DRAWING
(4012001-640) Sheet 2 of 2

A



RAME ASSEMBLY DRAWING (LEFT)
01-640) Sheet 2 of 2

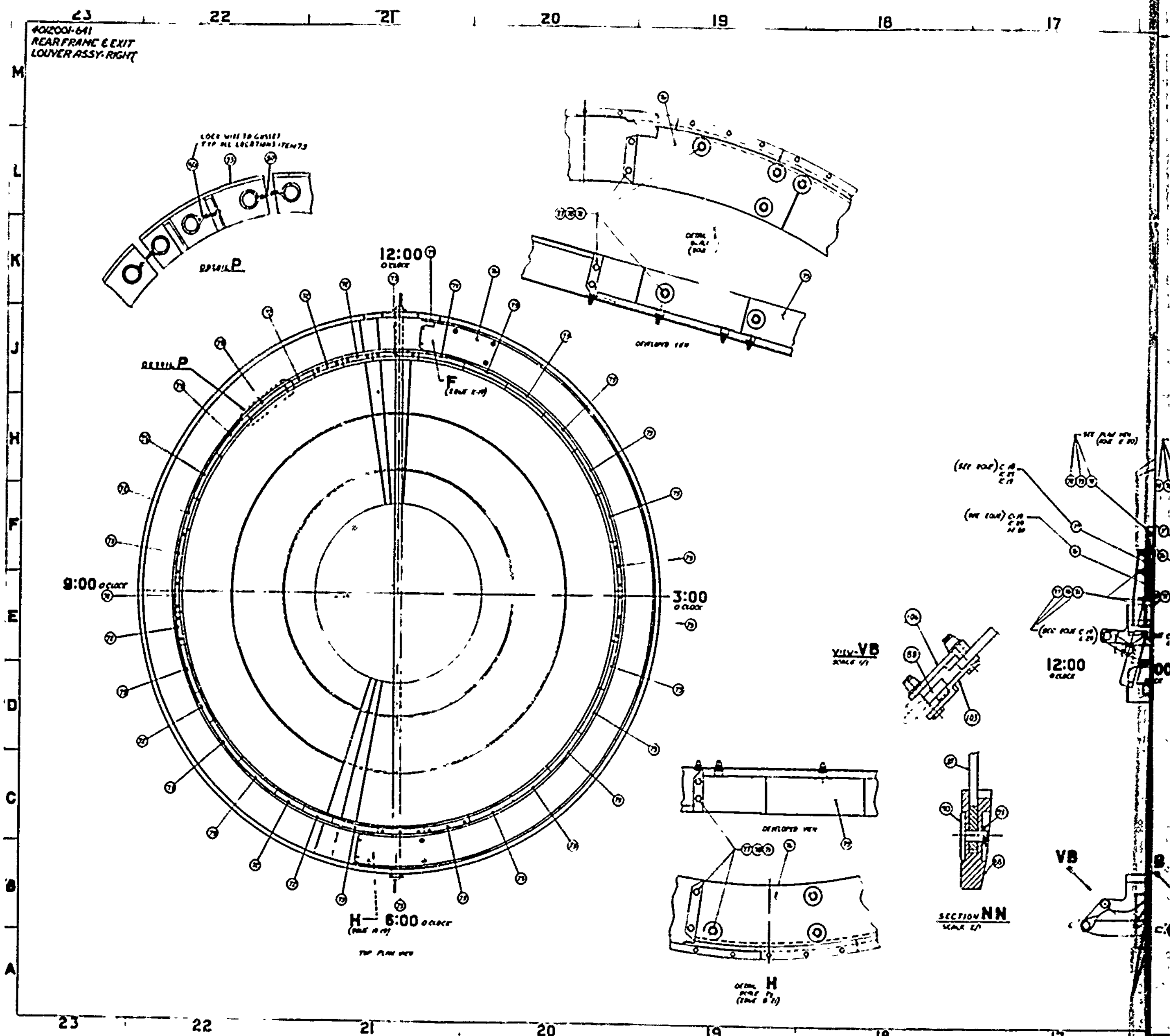
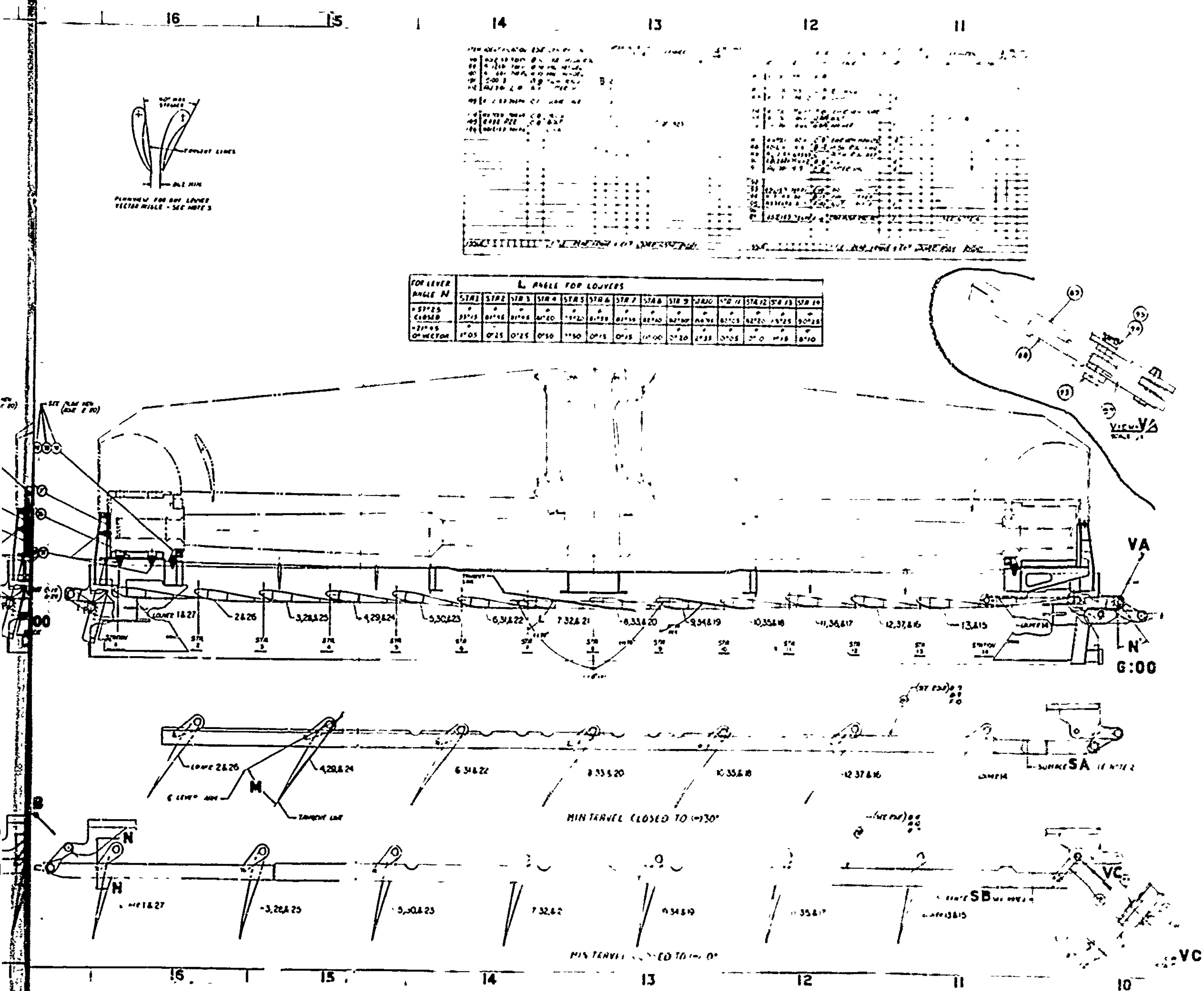


FIGURE 4.12 A ASSEMBLY DRAWING, REA
(4012001-641) Sheet

A

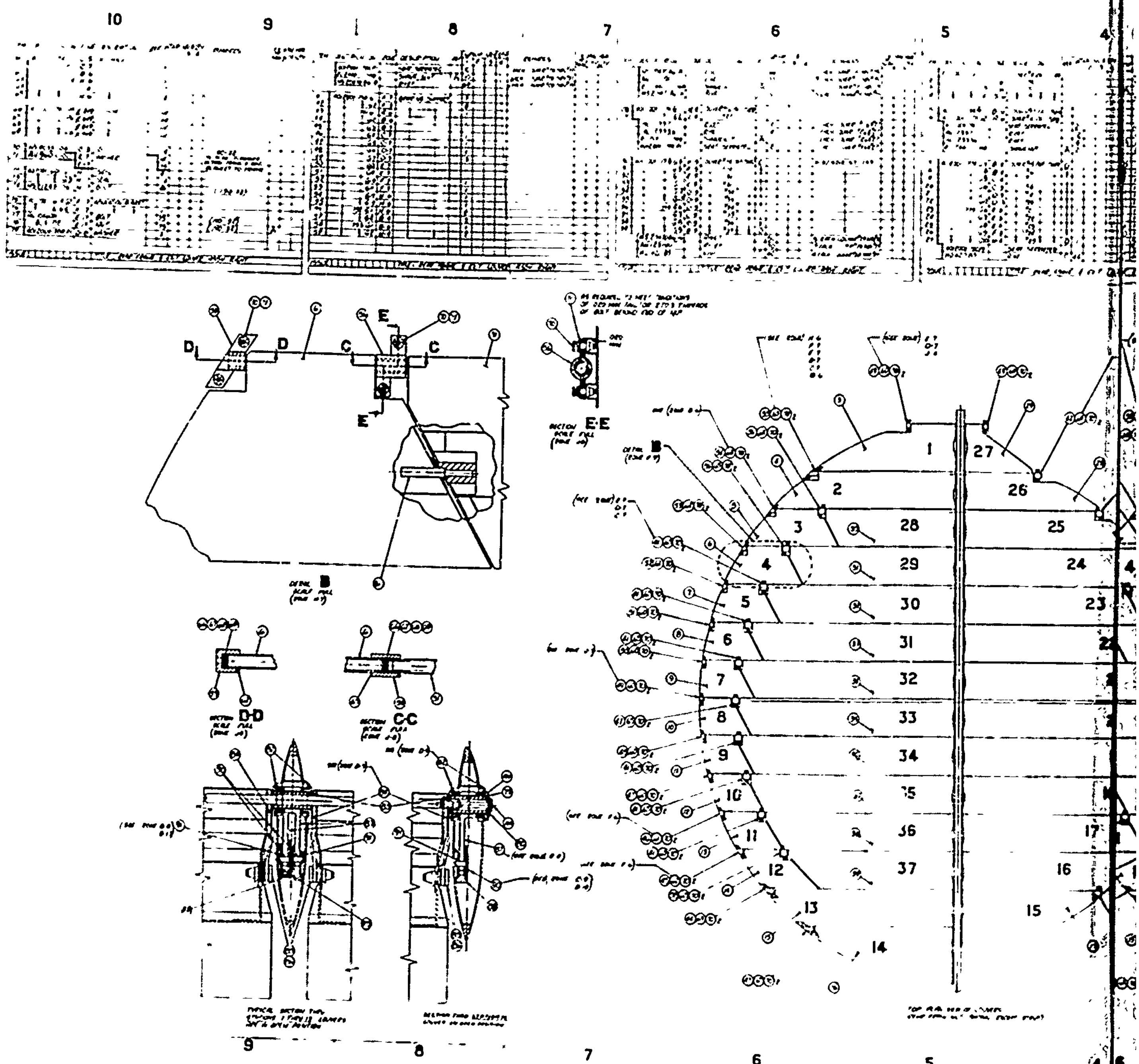


FOR LEVER ANGLE N	L ANGLE FOR LOUVERS													
	STA 1	STA 2	STA 3	STA 4	STA 5	STA 6	STA 7	STA 8	STA 9	STA 10	STA 11	STA 12	STA 13	STA 14
+57°25 CLOSED	[illegible]	[illegible]	[illegible]	81°20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	82°20	[illegible]	[illegible]
+21°05 0° VECTOR	1°05	0°25	0°25	0°50	[illegible]	[illegible]	0°15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0°10

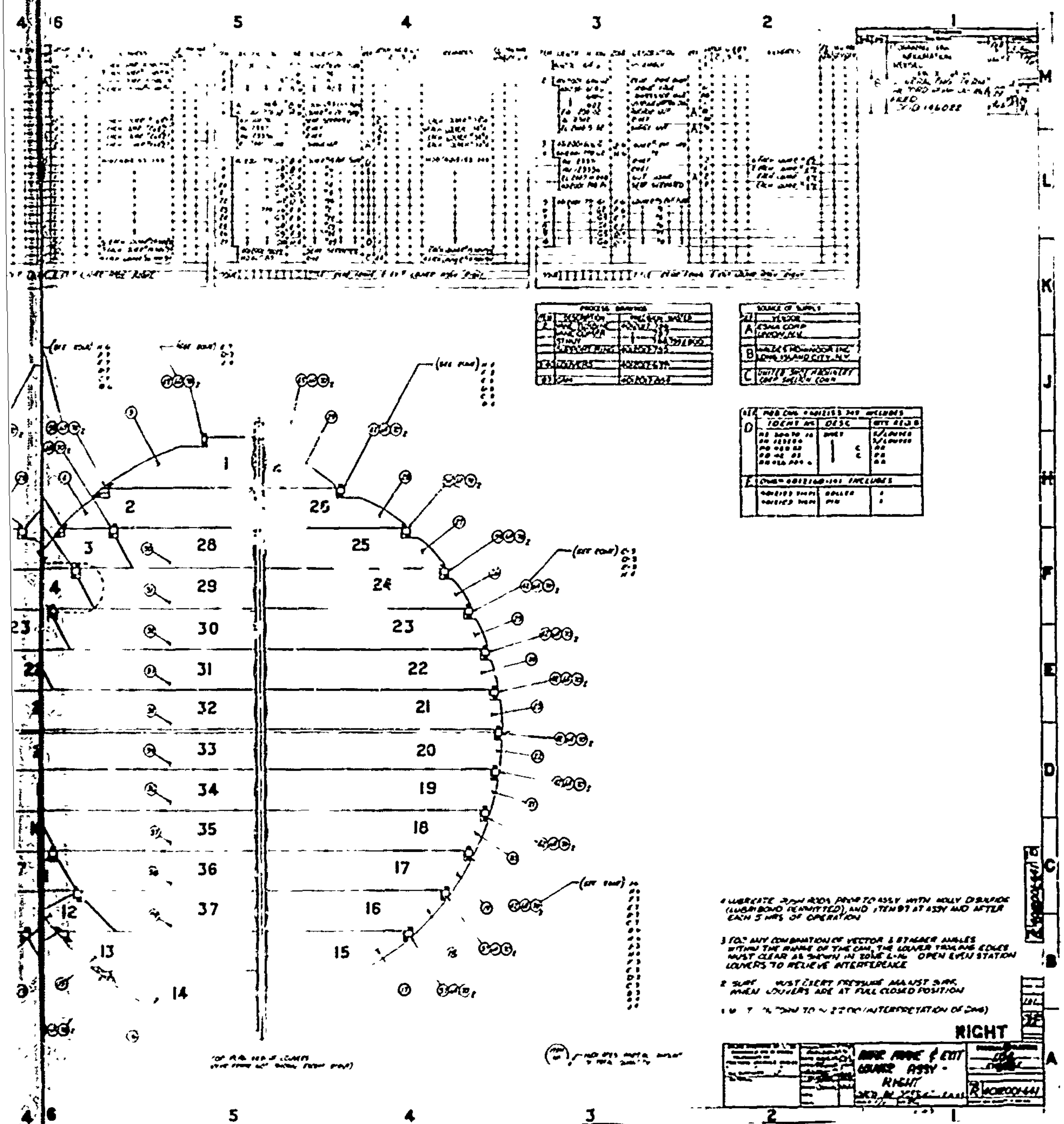
...G, REAR FRAME AND EXIT LOUVER (RIGHT)
Sheet 1 of 2

B

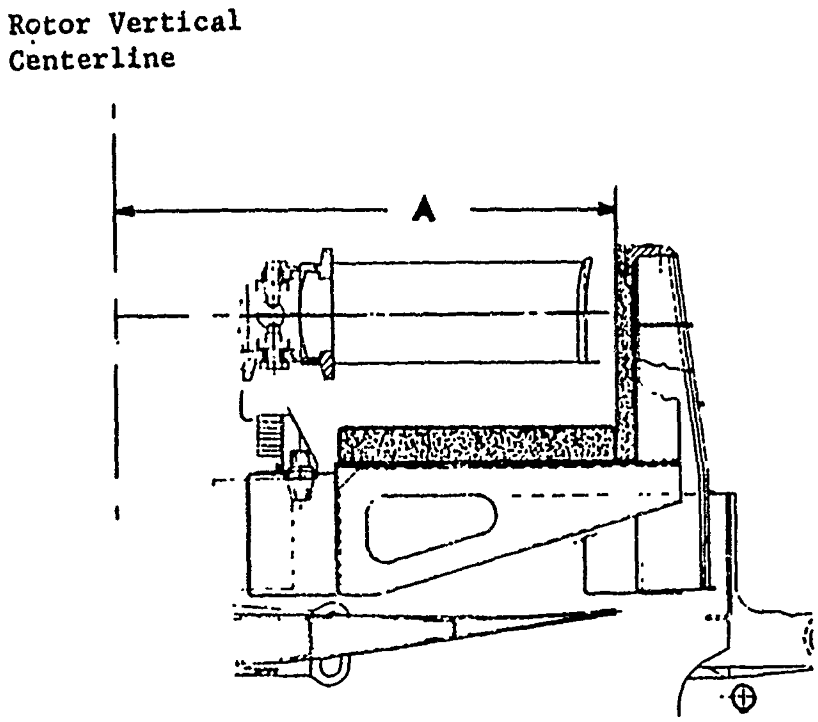
I-4.95



ASSEMBLY DRAWING, REAR FRAME AND EXIT LOVI
(4012001-641) Sheet 2 of 2



LOWING, REAR FRAME AND EXIT LOUVER (RIGHT)
Sheet 2 of 2



Measure and Record Dimension A

(1) Minimum Radius: 36.700"

(2) Actual Measurement: ____________

Figure 4.13 Inspection of Rear Frame Insulation Blanket Radius

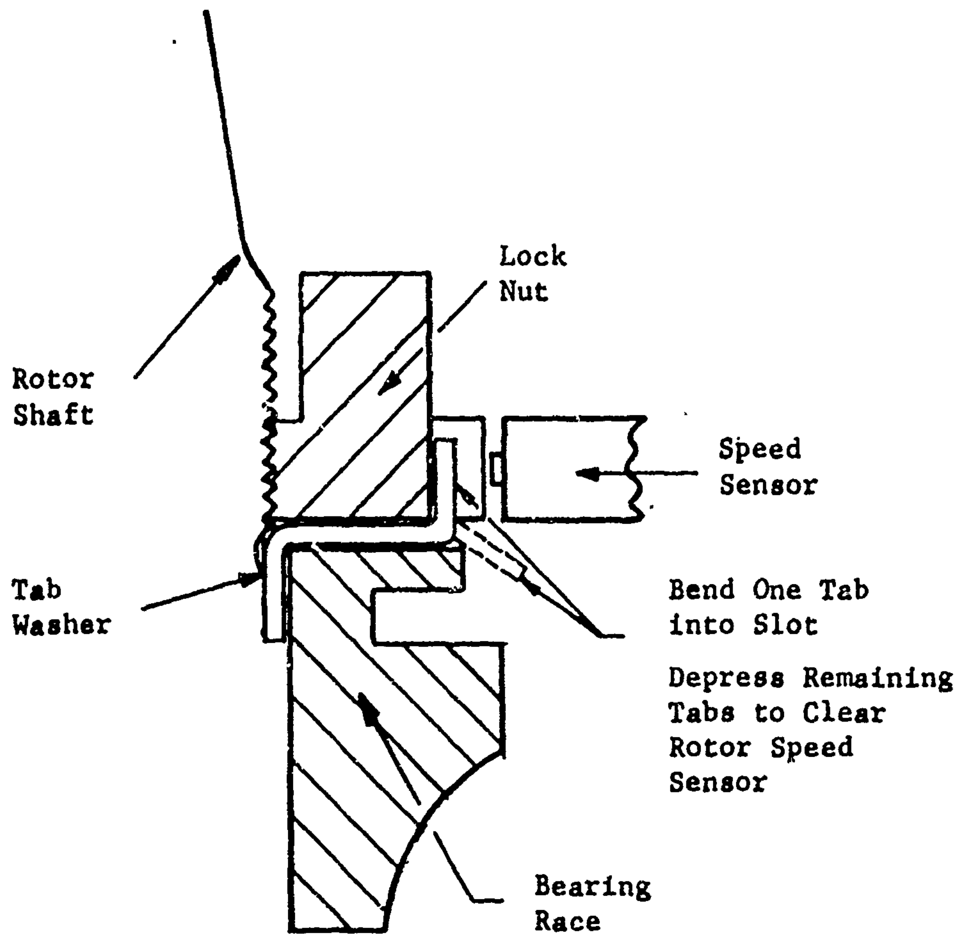
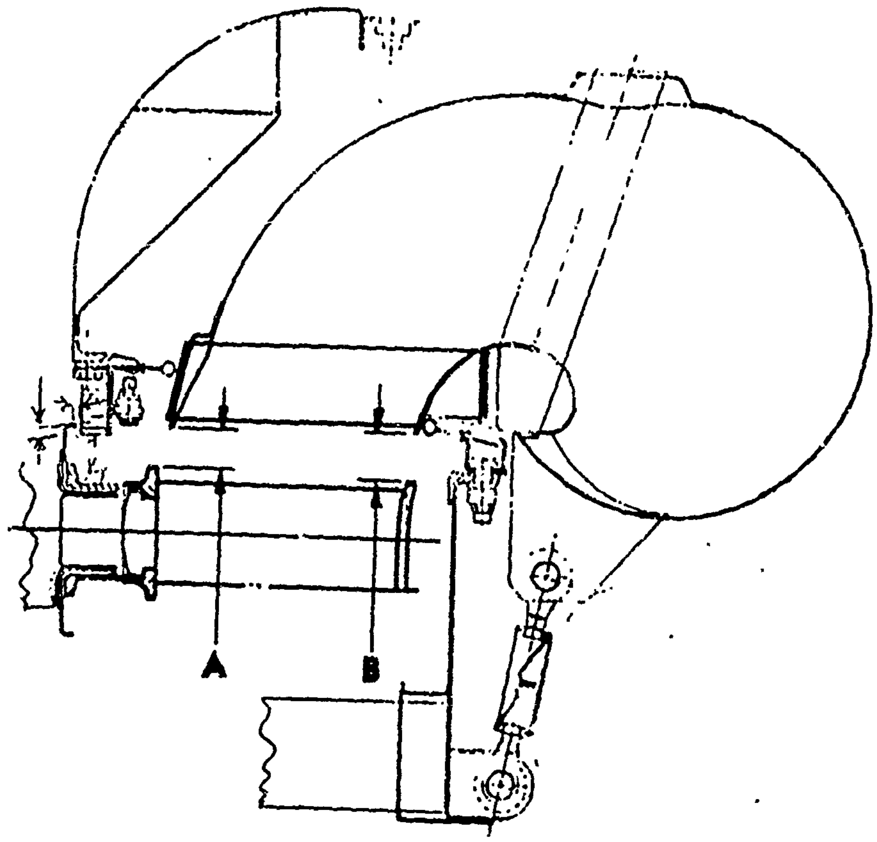


Figure 4.14 Assembly of Bearing Retaining Nut Tabwasher



	B/P	Actual
Dimension A	.750 Min.	.750 Min.
Dimension B		

Figure 4.15 Inspection of Rotor Axial Clearances

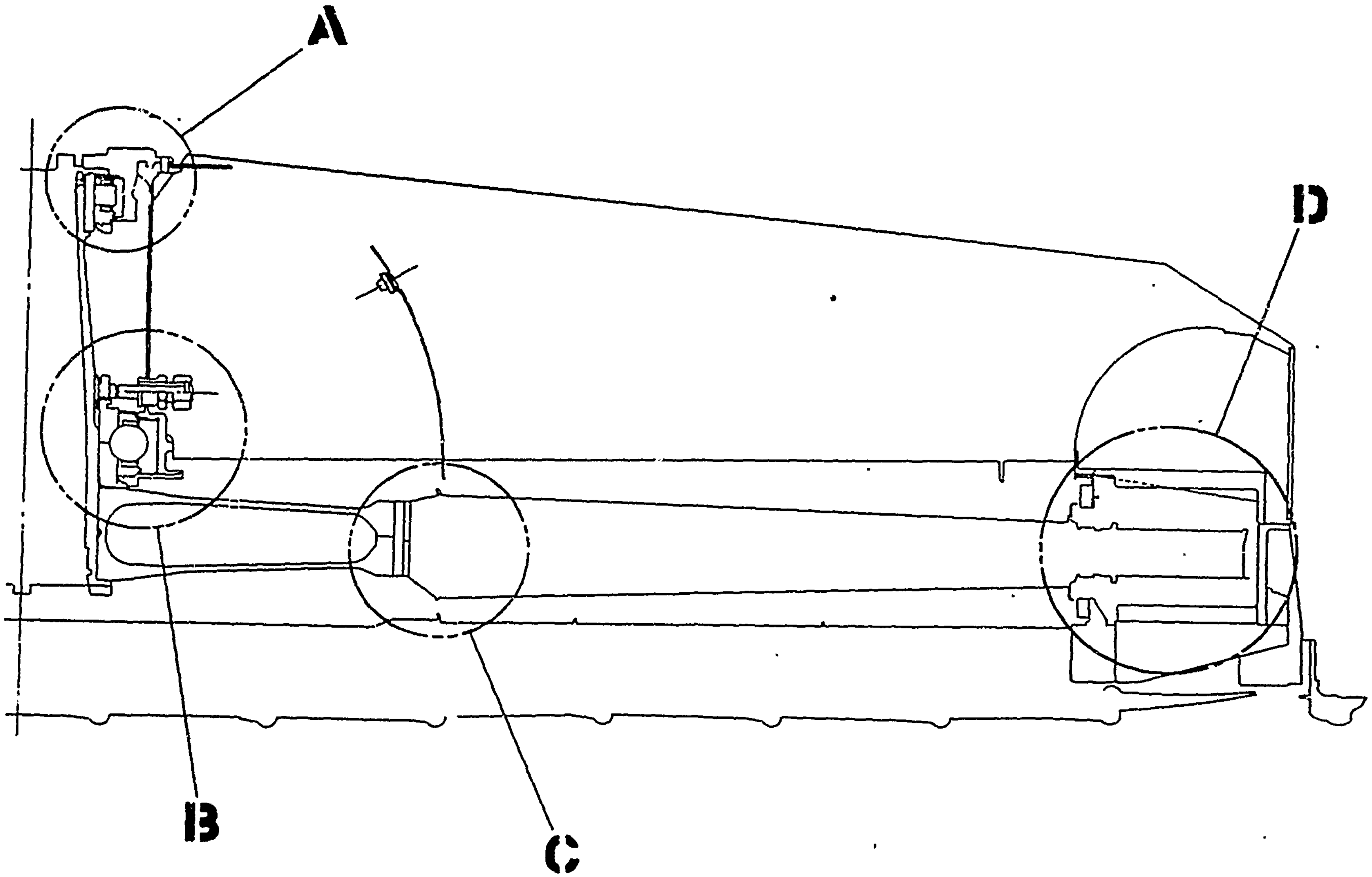
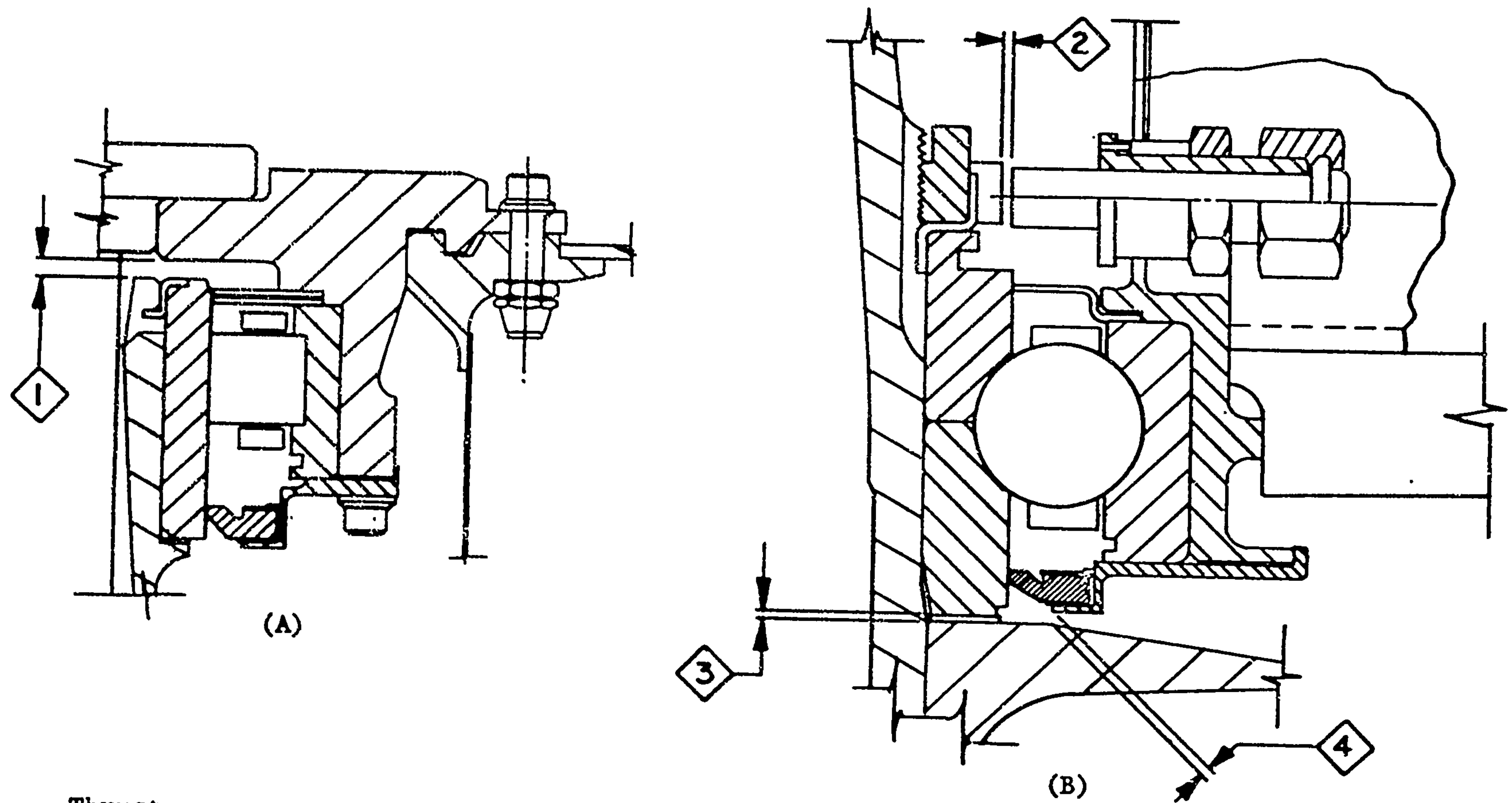


Figure 4.16A Reference Sketch for Final Inspection of Assembly

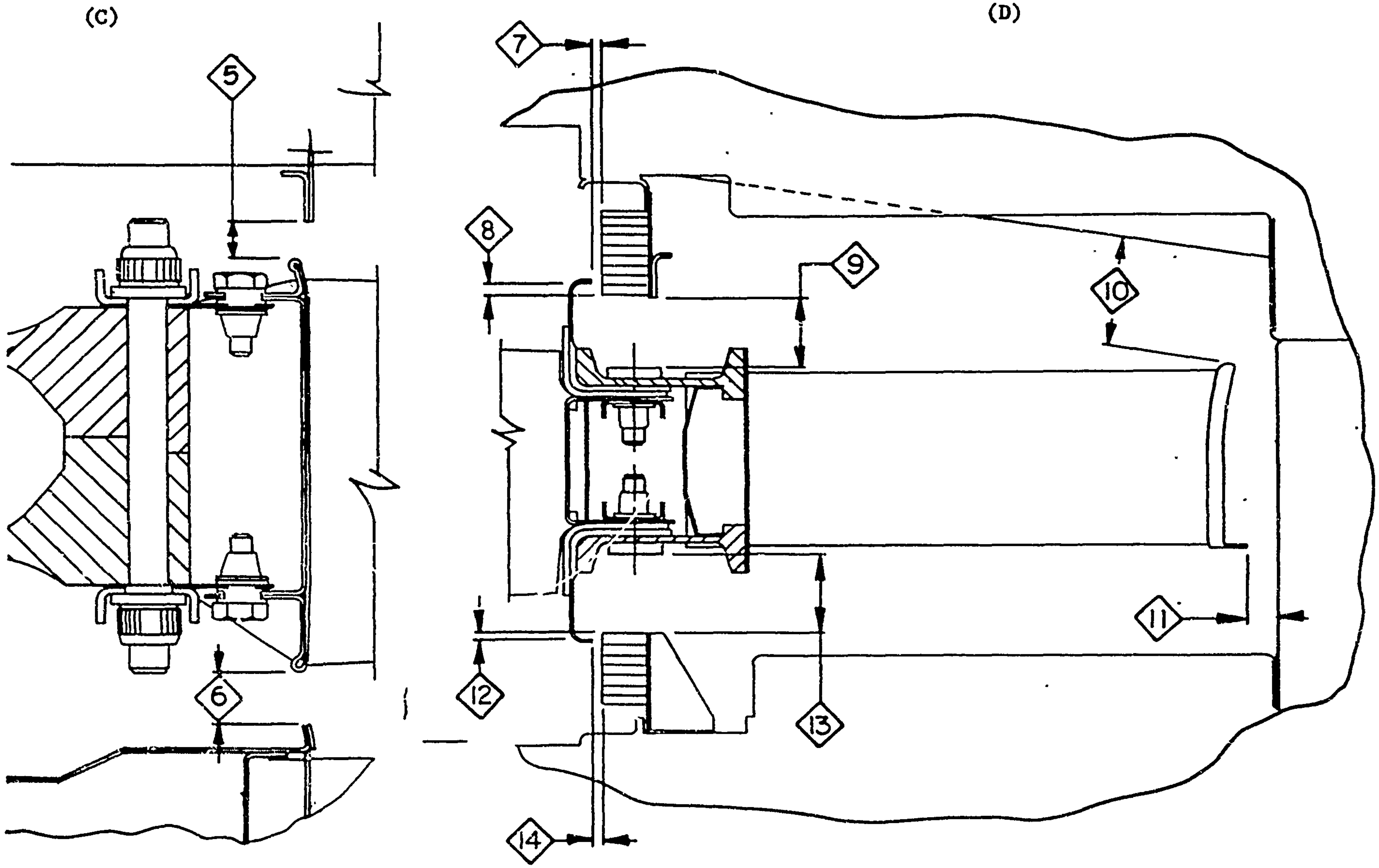


	Thrust Bearing Axial Play
B/P	.040
Actual	______

	Dim. #1*	Dim. #2	Dim. #3	Dim. #4
B/P	.090 Min.	.040 .020	A.R.	.090 Min.
Actual	______	______	______	______

*Inverted flight attitude when measured unless otherwise marked clearances are to be measured in normal flight attitude.

Figure 4.16B Rotor Bearing and Speed Sensor Clearance Inspection



	Dim. #5	Dim. #6	Dim. #7	Dim. #8	Dim. #9	Dim. #10	Dim. #11	Dim. #12	Dim. #13	Dim. #14
B/P	.400 Min	.230 Min	.095 Max .075 Min	-.060 Min +.060 Max	.600 Min	.750 Min	.300 Min	±.125 Min	.500 Min	.150 Max .140 Min
Actual										

Figure 4.16C Rotor Running Clearance Inspection

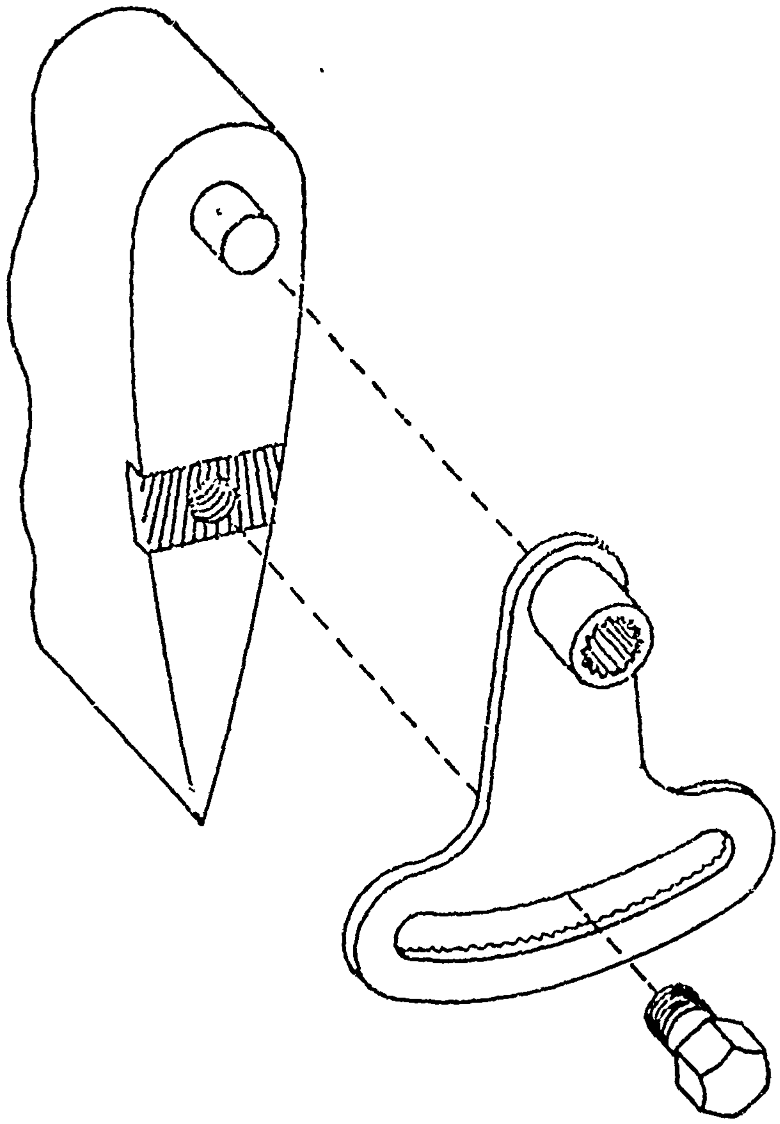


FIGURE 4.17 - ASSEMBLY OF ADJUSTMENT LEVER TO LOUVER END

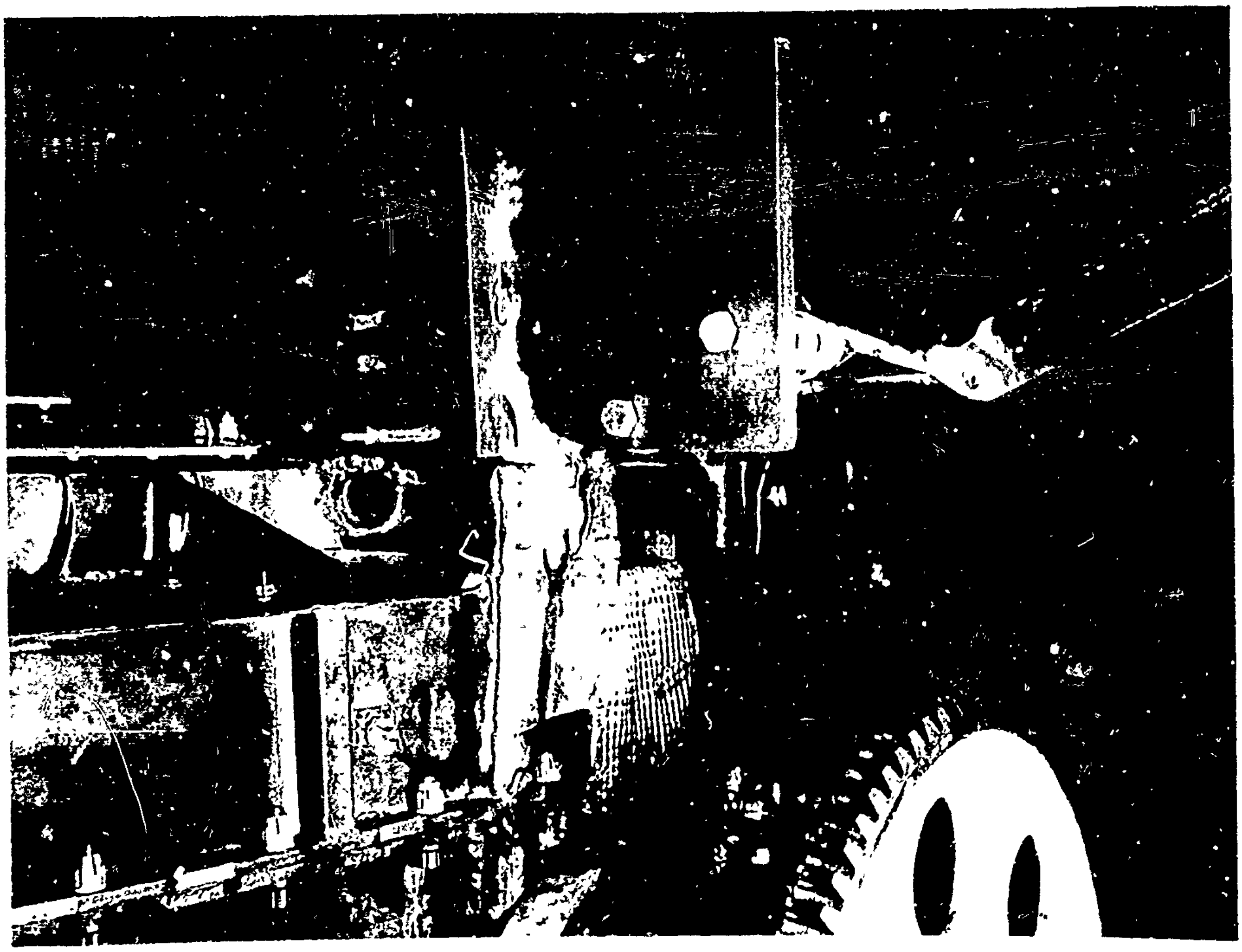
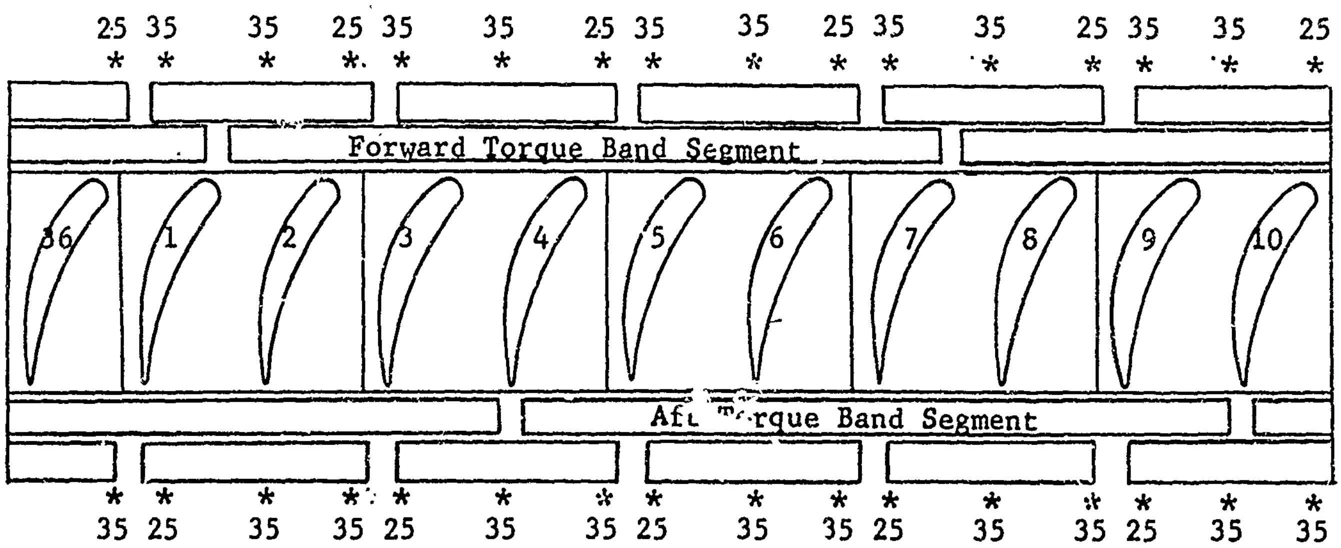


FIGURE 4.18 EXIT LOUVER LOCATION FIXTURE



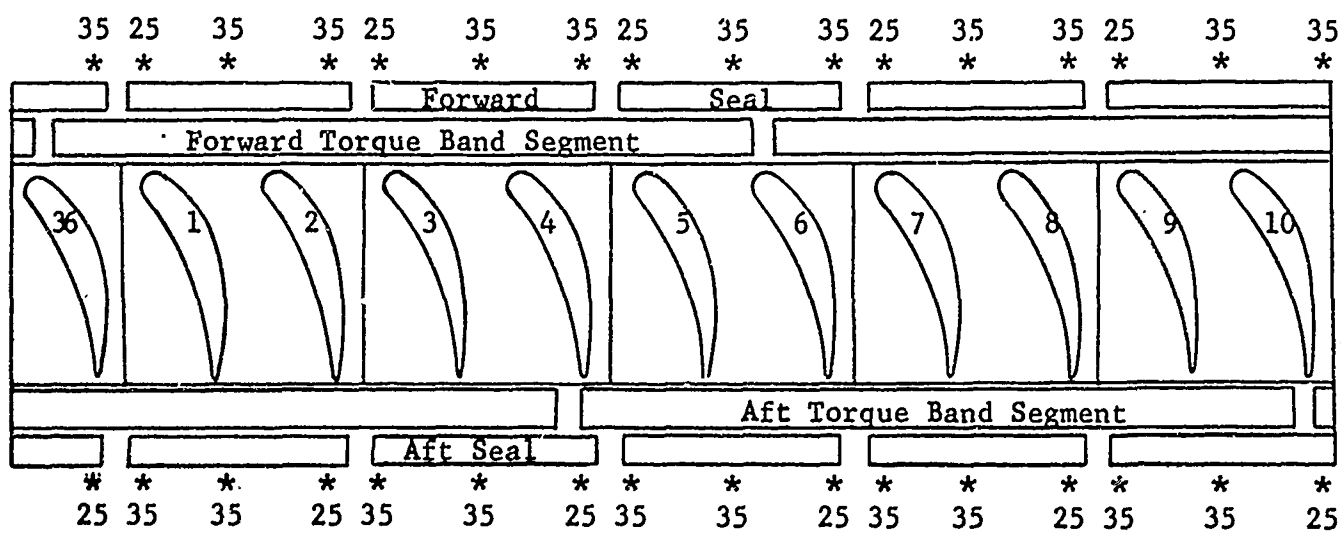
Inside Looking Out - Right Hand Rotor

Asterisk (*) indicates location of both; number adjacent to asterisk indicates torque value (lb. in.) to be applied to that location.

Note: The gaps between the forward torque band segments will be located at blade positions #1, 7, 13, 19, 25 and 31.

The gaps between the aft torque band segments will be located at blade positions #4, 10, 16, 22 and 34.

FIGURE 4.19A - TORQUING PROCEDURE FOR TORQUE BAND BOLTS - RIGHT HAND FAN



Inside Looking Out - Left Hand Rotor

Asterisk (*) indicates location of bolts; number adjacent to asterisk indicates torque value (lb. in.) to be applied to that location.

Note: The gaps between the forward torque band segments will be located at blade positions #6, 12, 18, 24, 30 and 36.

The gaps between the aft torque band segments will be located at blade positions #3, 9, 15, 21, 27 and 33.

FIGURE 4.19B - TORQUING PROCEDURE FOR TORQUE BAND BOLTS - LEFT HAND FAN.

4.51 DIVERTER VALVE ASSEMBLY

4.52 GENERAL

a. The diverter valve assembly consists of the following components:

1. Valve body
2. Doors (forward and aft)
3. Diffuser cone
4. Actuator linkage, and position switches
5. Insulation blanket

b. This instruction includes normal assembly, inspection and adjustment (refer to Figures 4.20, 4.21 and 4.22).

4.53 ASSEMBLE INSULATION BLANKET

a. Assemble both halves of the insulation blanket to the outside of the valve body and lace it in position with lockwire.

4.54 ASSEMBLE DOORS

4.55 Assemble Seal Springs, Seal Segments and Tube Seals

a. Each door is equipped with a flexible seal which extends around the periphery of the door. The seal for each door is assembled in two arcs. Each arc extends approximately half way around the door.

b. Slide the seal spring into the groove which extends around the periphery of the door.

c. Slide the seal segments over the end of the spring and into the groove. Note that the segment on the end of each arc is fitted with an end cap. After initial trial assembly of the segments, remove the segment and trim the length of each piece to obtain a total accumulated gap of 0.100" to 0.150" in each arc.

NOTE

Install the seal segments by sliding them in the direction of the spring coil winding to avoid snagging the edge of the segment on the spring.

d. Slide the seal tubes into the slots which are located on each side of the door between the seal end caps.

NOTE

Place a strip of masking tape over the edge of the door to hold the seal tubes in place until the door is ready for assembly into the valve body.

4.56 Assemble Doors to Valve Body

a. Insert the forward door into the body by sliding it through the opening in the diverted-flow leg of the valve body. The concave side of the door should face toward the inlet end of the body. The edge of the door having the largest radius (around circumference of door) should enter the opening first and will point toward the inlet end of the body.

b. Assemble the actuator clevis to the forward door lever arm and secure it with a pin, washer and cotter pin.

c. Align the torque shaft holes in the valve body and forward door and insert the torque plug through the valve body bushing and into the recess in the door. Slide the torque shaft through the valve body and into the recess in the side of the door.

d. Attach the required amount of shims to the torque shaft which is to be assembled to the opposite side of the valve. Slide the pin through through the valve body bushing and into the door recess. Insert two bolts into each torque shaft and tighten by hand (to avoid cross-threading the bolt and shank nut). Torque the bolts to 160 lb. in.

e. Insert the aft door through the opening at the aft end of the valve body and assemble the torque shafts following the same procedure used on the forward door. Note that the flat face of the door faces the forward end of the valve. When viewing the flat face of the aft door, one arc of the seal segments faces away from the assembler and one arc faces toward the assembler. The segments which face toward the assembler when viewing the flat face of the door, should be positioned near the diverted-flow leg of tl valve body.

f. With either door in the closed position, the seals should contact the valve body for the entire periphery of the door and be depressed a minimum of 0.060 at the leading and trailing edges. If gaps do exist, remove seals and build up using L605 filler wire (AMS 5796). Reassemble seals, remove sharp corners and bench weld buildup to fit valve body. The maximum allowable buildup height is 0.12".

4.57 ASSEMBLE DIFFUSER CONE

a. Slide the diffuser cone into the forward end of the valve body and align the arms with the support slots. Slide four support blocks (with gaskets) into the support arms. Attach four bolts and nuts to each support and torque to 25 - 35 lb. in.

4.58 INSPECTION

a. The forward end of the diffuser cone must not extend more than 0.510" beyond the forward face of the valve body forward flange and it must be centered in the valve body within 0.050".

4.59 ASSEMBLE ACTUATOR LINKAGE

a. Assemble the clevis link to the door lever arms using a pin, washer and cotter pin on each end. The side of the lever arm which contains the cotter pin should face away from the valve body. The short end of the clevis link should be connected to the forward door lever arm.

b. Assemble a clevis to one adjustable stop link and a rod end to the other adjustable stop link. The link which has the rod end is connected to the forward door lever arm with a pin, washer and cotter pin (the pin head should be adjacent to the valve body). Place tension on the linkage by closing the forward door; while holding it closed by hand, adjust the link by turning the rod end until the link rests against the pin in the forward lever arm.

c. The link which has the clevis-end is assembled to the aft door lever arm and is adjusted in the same manner with the aft door held closed. Attach the adjustable links to the clevis link with a pin, washer and cotter pin. The head of the pin is located adjacent to the valve body.

NOTE

Ref. Dwg. 4012001-912 to locate pin "F".
Cotter pin is towards valve body.

4.60 ASSEMBLE ACTUATOR

a. Assemble the actuator bracket over the bracket support and insert the pin and lock in place using a cotter pin. Bolt the bracket to the forward flange using AN washers as shims to obtain a minimum gap of 0.075" forward and 0.090" aft axially between the bracket and the bracket support.

CAUTION

This minimum gap must be met to insure clearance during uneven thermal growth between the valve body and the actuator bracket. This gap is a cold clearance and will change during operation.

LUBRICATION

To decrease friction during thermal cycling of the valve, lubricate the axial pin at assembly with Molly Disulfide (Lubri-bond permitted). Re-lubricate each succeeding five hours of operation.

b. Assemble the actuator push rod to the rod end on the forward door lever arm. Screw a sleeve onto the push rod and screw the push rod into the rod end until the uniball end of the actuator fits into the actuator bracket and the pin holes line up. Insert a pin, washer and cotter pin.

NOTE

The actuator should be fully retracted and the doors should be in the straight-through mode. This positioning should leave all overtravel in the actuator in the extended position end. Tighten the sleeve and fasten with lockwire.

4.61 ASSEMBLE DOOR POSITION SWITCHES

NOTE

To assemble and adjust the position switch, the system must be hydraulically locked in the same mode as the switch is to be installed in. (3000 psi)

CAUTION

Do not install the switches on the valve body before the door travel stops are adjusted and locked. Whenever the stops are changed, a new adjustment will be required on the switch.

a. Insert the switch into the bracket from the side opposite the door arm, with a jam nut and lock washer. Slide a washer and nut over the end of the switch and tighten.

b. Adjust the switch until a gap between the end of the switch body and the door arm is 0.060" to 0.080". The plunger in the switch will be retracted until approximately 1/16" is protruding. After adjustment, tighten the jam nuts and lockwire.

CAUTION

These switches are adjusted in the cold position and may change their relative adjustment while the engine is in operation or while the diverter valve is still hot. Do not adjust the switch during operation or when it is hot. Do not adjust without hydraulic power.

c. Preventative Maintenance - At initial installation, coat the switch plunger with Molydisulfide in the full extended position. During operation the plunger should be coated as often as possible but no longer than 5 hours of operation.

NOTE

The circuit diagram is as shown on Figure 5.1.

d. Position Switch Trouble Shooting - Remove the connector from both switches on the valve. Move the valve door to the CTOL mode. Check the switch that is depressed. This switch should read continuity between pins B and F and C and E. The opposite switch should read continuity between pins B and A and C and D. Change the position of the diverter valve mode to VTOL and make the same check. If no continuity is received, replace the switch.

4.62 ASSEMBLE DIVERTER VALVE TO J85-5 ENGINE

a. Slide the front end of the diverter valve flange over the turbine case and line up with the diverted leg pointing down. Insert the flange bolts with the lift eye at top center and the anti-torque bracket. Torque the bolts and nuts to 25 - 35 lb. in.

b. Assemble the bleed ducts using a gasket and seven nuts to each duct. Torque the nuts to 15 lb. in.

c. Assemble the thermocouple harness and tighten the nuts and fasten with lockwire. Hook up the amphenol connector to the engine leads and fasten with lockwire.

4.63 DISASSEMBLY OF ACTUATOR

a. Remove the cap nut from the fixed end of the actuator by breaking the lockwire and turning CCW. (See Figure 4.22 for actuator details)

b. Remove the uniball end cap by twisting slightly and pulling away from the actuator housing.

c. Remove the "O" ring and back up ring.

d. Remove the nut from the end of the actuator piston rod.

e. Remove the end nut from secondary end of the actuator. Then pull the piston rod out of the housing. This will also remove the secondary packing gland which can not be removed from the threaded end of the piston rod.

f. The center packing gland can be removed by breaking the lockwire and removing the small allen head set screw about half way down on the actuator housing. Then remove the 25 steel balls that are used to hold the gland in position. Slide the gland out of the housing.

g. Replace "O" rings or back up rings one at a time so that the relationship and location is not lost.

4.64 ASSEMBLY

a. Slide the center gland into actuator housing and center. Insert the 25 steel balls, the allen head set screw, tighten and lockwire.

b. Slide the piston into the housing through the center packing gland with the secondary piston gland touching the center gland.

c. Slide the primary piston gland over the piston rod and assemble the locknut and tighten.

d. Slide the secondary packing gland over the threaded end of the piston rod and into the actuator housing. Assemble the end nut, tighten and lockwire.

e. Slide the uniball end into the actuator housing. Assemble the nut cap, tighten and lockwire.

4.65 ACTUATOR PRESSURE TEST

a. Proof test the primary and secondary systems to 4500 psi in the retracted and extended position.

b. Observe leakage from the seal drain port. Maximum leakage allowed, one drop per 10 cycles of operation.

c. To trouble shoot leakage apply pressure as follows:

System		Position			
Primary	Secondary	Extend	Retract	Leaks	Replace
	X	X		End Cap	End Cap "O" Rings
	X		X	Drain	Center Gland - "O" Rings
X		X		Drain	Center Gland - "O" Rings
X			X	Drain	End Gland - "O" Rings

4.66 Diverter Valve Coupling Description

a. To insure that both diverter valves are always in the same flight mode a mechanical coupling is installed between the straight doors on the left and right valves. A splined torque shaft is installed on the inboard side of each valve at assembly of the valve. The coupling is assembled after the valves are installed in the aircraft.

c. Slide the primary piston gland over the piston rod and assemble the locknut and tighten.

d. Slide the secondary packing gland over the threaded end of the piston rod and into the actuator housing. Assemble the end nut, tighten and lockwire.

e. Slide the uniball end into the actuator housing. Assemble the nut cap, tighten and lockwire.

4.65 ACTUATOR PRESSURE TEST

a. Proof test the primary and secondary systems to 4500 psi in the retracted and extended position.

b. Observe leakage from the seal drain port. Maximum leakage allowed, one drop per 10 cycles of operation.

c. To trouble shoot leakage apply pressure as follows:

System		Position			
Primary	Secondary	Extend	Retract	Leaks	Replace
	X	X		End Cap	End Cap "O" Rings
	X		X	Drain	Center Gland - "O" Rings
X		X		Drain	Center Gland - "O" Rings
X			X	Drain	End Gland - "O" Rings

4.66 Diverter Valve Coupling Description

a. To insure that both diverter valves are always in the same flight mode a mechanical coupling is installed between the straight doors on the left and right valves. A splined torque shaft is installed on the inboard side of each valve at assembly of the valve. The coupling is assembled after the valves are installed in the aircraft.

4.67 Diverter Valve Splined Torque Shaft Assembly

NOTE

The XV-5A diverter valve assemblies were delivered without the splined torque shafts installed. The valves were modified in the field per the following instructions:

a) Remove the inboard torque shaft and shims from the straight door.

b) Insert a torque plug, then insert the splined torque shaft with a spacer into the body and door trunnion. Insert the bolt and tighten to 160 lbs. in.

4.68 Diverter Valve Coupling Assembly

a. Assemble the two coupling items together by inserting the left hand (smaller diameter) into the right hand (larger diameter) part and compress to its shortest length.

b. Insert the spline end of the right end of the coupling assembly into the end of the right hand spline torque shaft.

NOTE

When the doors are in the conventional mode, the bolt hole in the coupling should be vertical.

c. Expand the coupling into the left hand splined torque shaft until an axial gap of 0.100" to 0.150" is obtained.

d. Hydraulically load the valves in the conventional mode and match drill and ream the coupling assembly. Repeat the same procedure for the VTOL mode and elongate the bolt hole to insure that the individual valve door travel stop is seating and not transmitting torque through the coupling.

NOTE

The valve body door stops must not be readjusted without checking to insure that the coupling is free to slide axial within the 0.100" to 0.150" gap in the splines.

e. Insert the coupling bolt, tighten the nut enough to hold the bolt in place without binding the coupling assembly to eliminate torsional movement between the two coupling parts. Lockwire the bolt head to the nut.

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-915G1	Assembly - Diverter Valve Coupled	-
2	4012001-937G2	Diverter Valve - Left Hand	1
3	4012001-938G2	Diverter Valve - Right Hand	1
4	4012001-964P1	Hub - Coupling	1
5	4012001-966P1	Hub - Coupling	1
6	4012001-972P1	Bolt	1
7	4012153-274P9	Nut	1

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-937G2	Assembly - Diverter Valve - Left Hand	--
2	4012001-914G2	Valve Body - Phase III	1
3	4012153-339G5	Door Forward	1
	4012054-580P21	Nut	2
4	4012153-338G4	Door Aft	1
	4012054-580P21	Nut	2
5	4012090-894G1	Seal Segment	AR
6	4012153-371G3	Seal Segment, End	4
7	4012153-371G4	Seal Segment, End	4
8	4012153-372G1	Seal Tube	8
9	4012153-373P1	Seal Tube	4
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20	MS9033-12	Bolt	10
21	MS9033-10	Bolt	38
22	4012153-386P1	Spring	4

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
23	LHSS-16	Spherical Bearing	2
24	5000-175	Retaining Ring	2
25	R1068P1	Bolt	16
26	AN995N32	Lockwire	AR
27	841B660P1	Nut Strap	16
28	841B661P1	Support	4
29	841B653P1	Gasket	4
30	37R601158P121	Doubler Half	4
31	37R601158P129	Shell	1
32	37R601158P128	Nose	1
33	37R601158P120	Support Half	8
34	37R601158P114	Cover	1
35	37R601158P115	Deflector	1
36	37R601158P110	Strut Half	4
37	37R601158P111	Strut Half	2
38	37R601158P125	Doubler Half	4
39	Z1200-02	Nut	48
40	4012001-920P1	Bracket - Lifting	1
41	4012011-921G1	Bracket - Support	1
42	LSS4	Spherical Bearing	1
43			
44	AN960C10	Washer	21
45	12HR12-RB	Micro-Switch	3
46	H41-08	Nut	14

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
47	42H24097P3	Insulation Blanket	1
48	42H24097P5	Insulation Blanket	1
49	37B201596P101	Gasket	2
50		Assembly	X
51	4012001-936G3	Valve Div. Act. System Assembly	1
52			
53	HR-10033	Nut, Hex	6
54	HR-10030	Washer, Lock	6
55	8TE5AAK1	Thermocouple Harness - Right Hand	1
56	8TE5AAH1	Thermocouple Harness - Left Hand	1
57	37E501418P110	Duct - Leakage	2

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-936G3	Assembly - Actuation, Left	--
2	4012001-933G1	Assembly - Linkage Forward Door	1
3	4012153-374G1	Assembly - Linkage Rear Door	1
4	4012153-356P1	Torque Shaft	1
5	4012153-359P2	Clevis	1
6	4012153-360P1	Link	2
7	4012153-361P1	Clevis	1
8	4012153-362P1	Rod End	1
9	4012001-934G1	Actuator Support	1
10	4012090-898P1	Pin (.375 Dia.)	4
11	4012090-897P1	Pin (.4375 Dia.)	1
12	4012090-896P1	Pin (.250 Dia.)	1
13	AN960C616L	Washer	10
14	AN960C10	Washer	AR
15	AN960C716L	Washer	2
16	AN960C416L	Washer	2
17			
18	4012001-939P1	Rod End	1
19	4012001-932P1	Actuator - Tandem	1
20	AN-381-3-16	Cotter Pin	8
21	MS20995C47	Lockwire	AR
22	4012153-381P2	Washer	AR
23	4012153-324P3	Bushing	4
24	4012153-331P1	Torque Plug	3

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
25	R108P20	Bolt	4
26	AN316C7	Nut	2
27	4012153-381P1	Washer	4
28			
29	4012001-933G2	Assembly - Linkage Forward Door	--
30	4012090-898P2	Pin (.375 Dia.)	1
31	4012001-935P1	Pin (.375 Dia.)	1
32			
33			
34	4012001-969P1	Torque Shaft	1
35	4012001-970P1	Shim	1
36	4012001-983P1	Sleeve	1

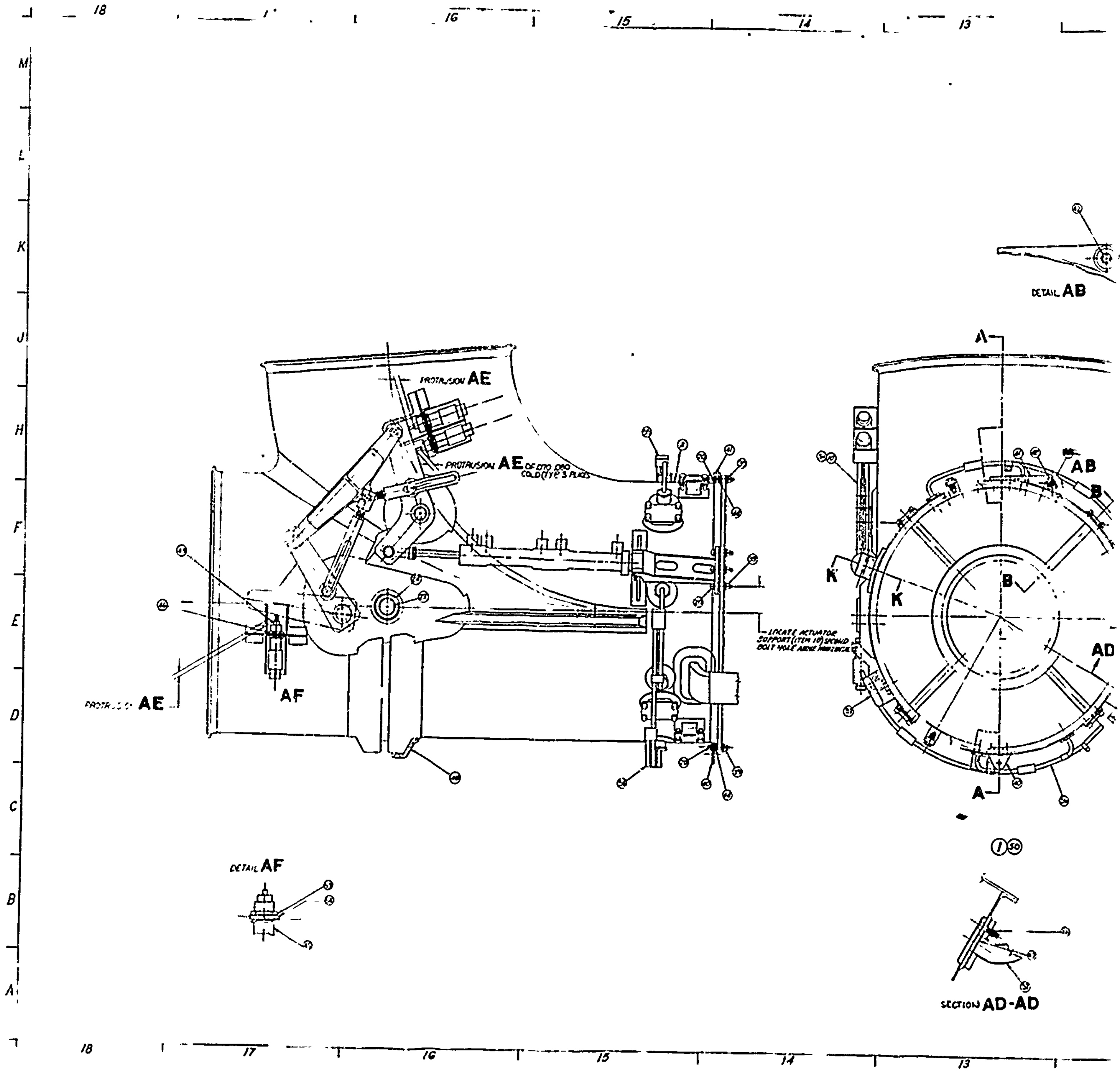
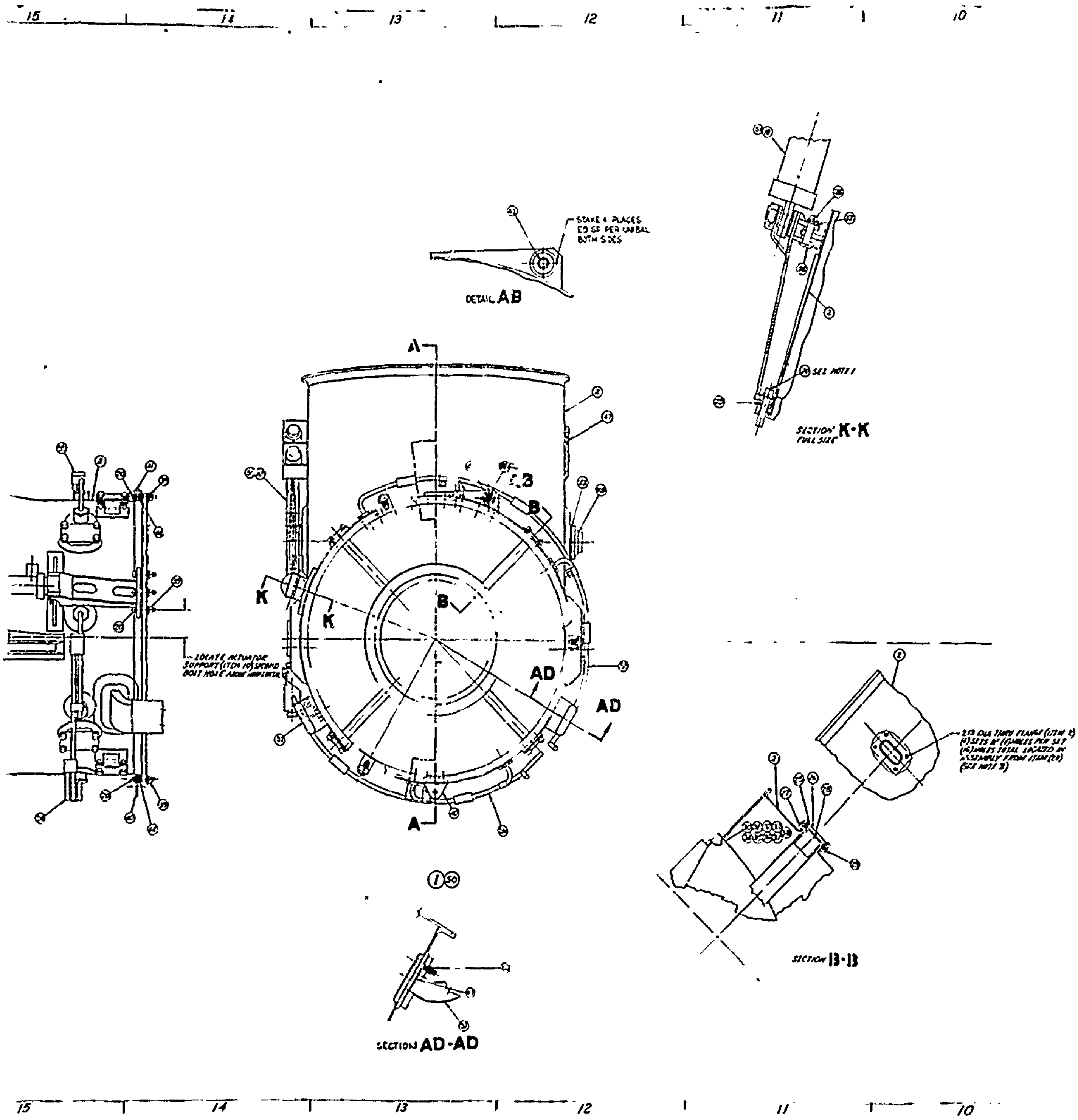


FIGURE 4.20 ASSEMBLY DRAWING, LEFT HAND DIVERTER VALVE (4012001-937) Sheet 1 of 2

A



ASSEMBLY DRAWING, LEFT HAND DIVERTER VALVE
(4012001-937) Sheet 1 of 2

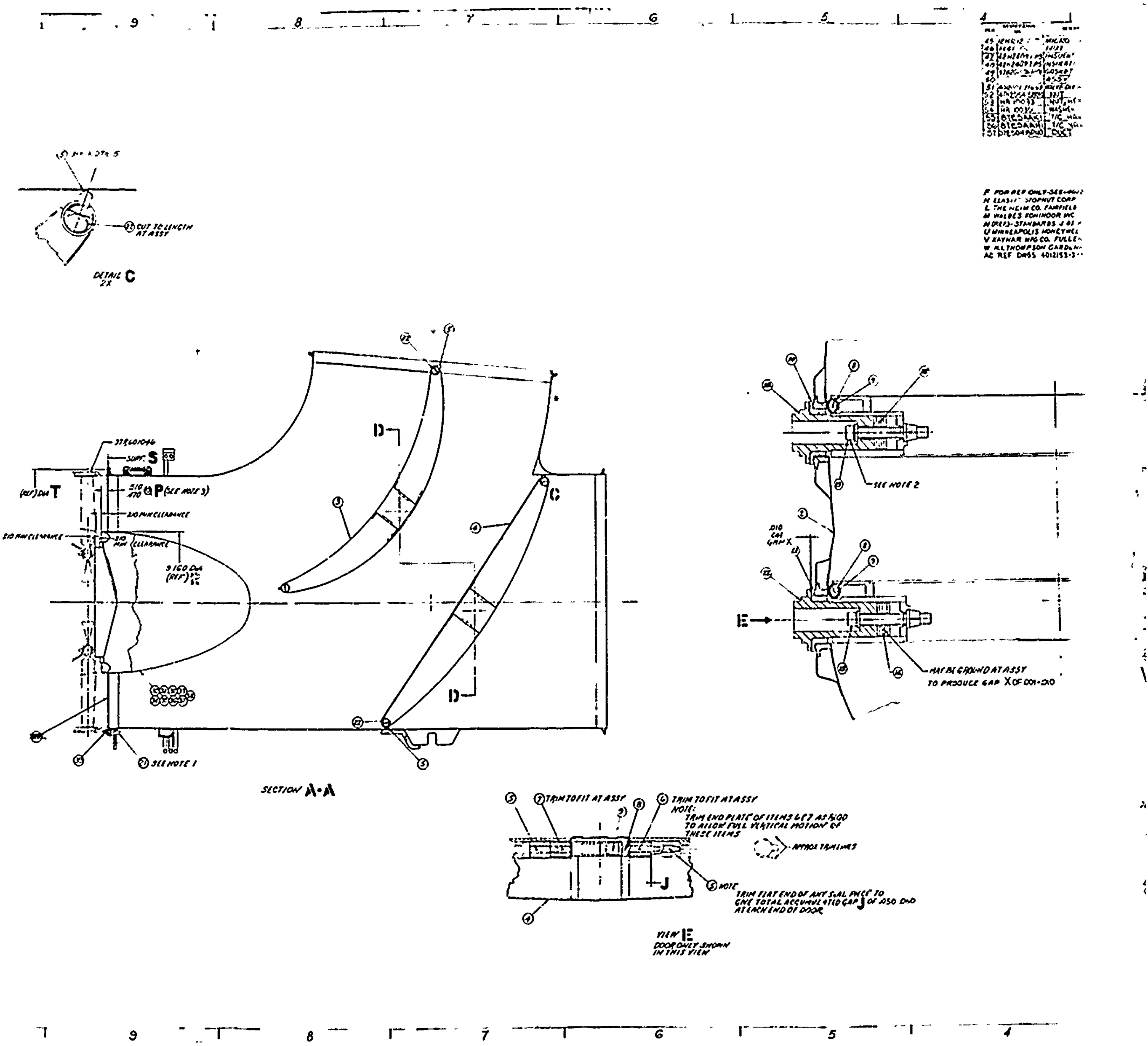
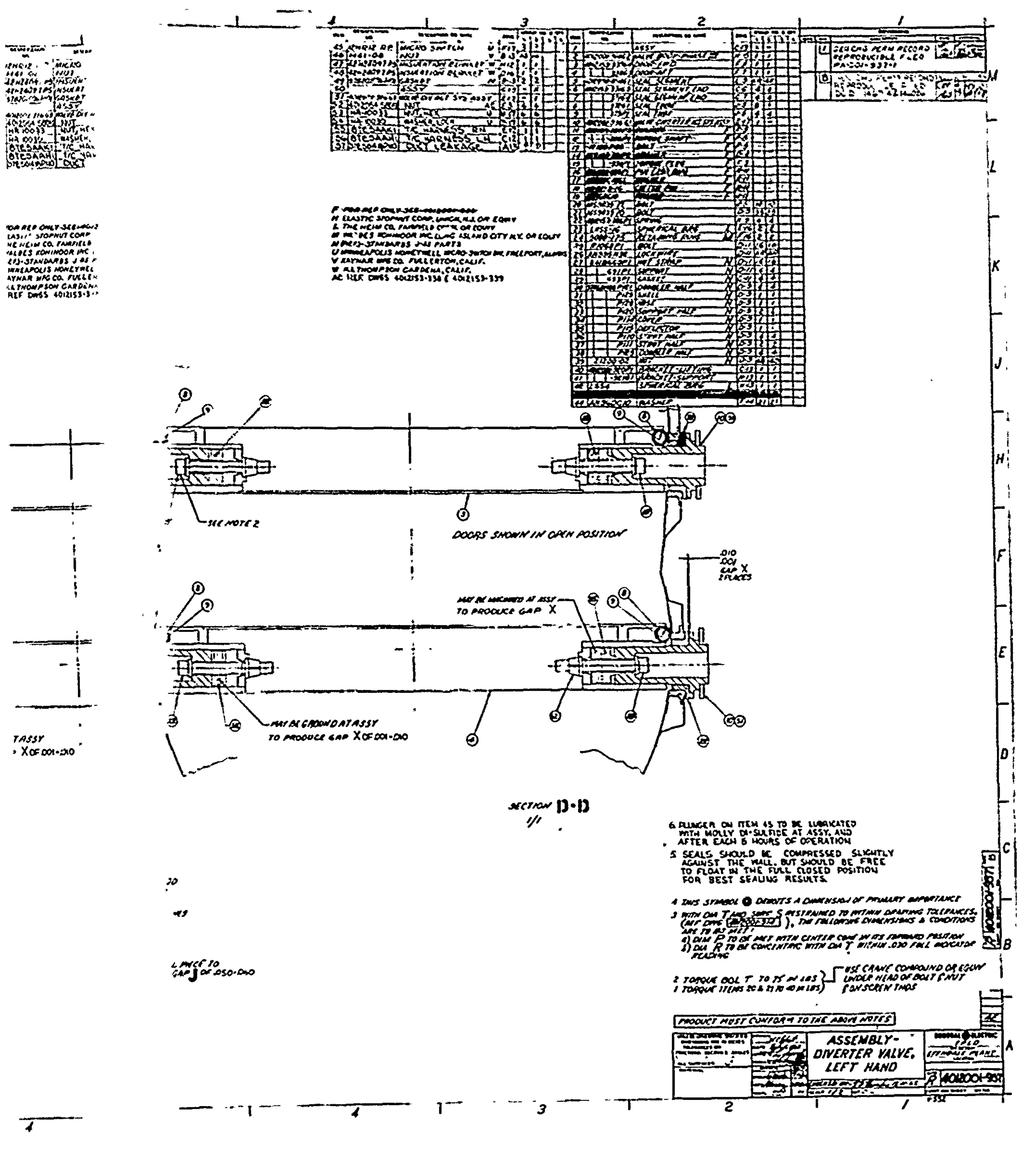
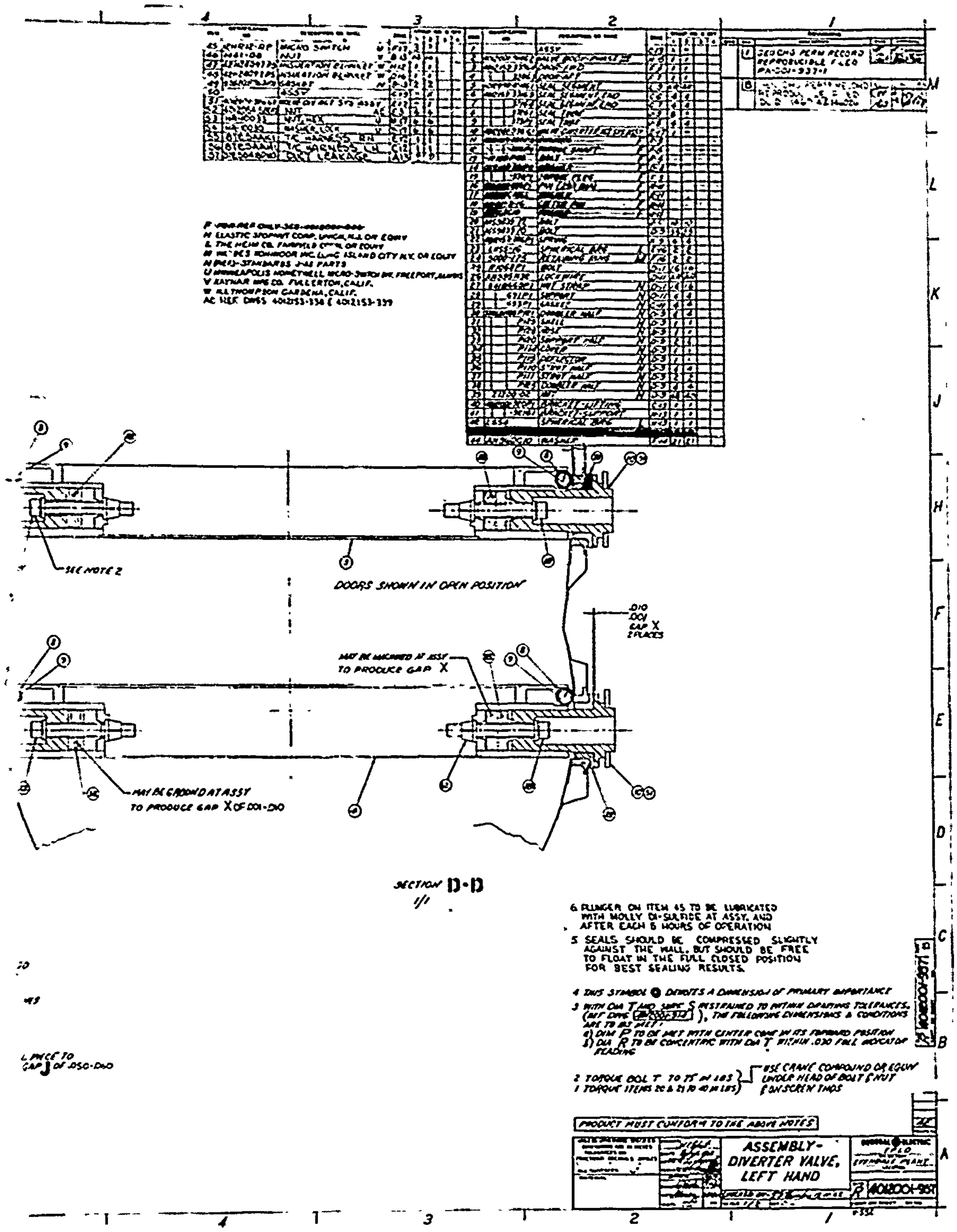


FIGURE 4.20 ASSEMBLY DRAWING, LEFT HAND DIVERTER V··, (4012001-937) Sheet 2 of 2



VERTER V..., LEFT HAND DIVERTER VALVE
heet 2 of 2



…, LEFT HAND DIVERTER VALVE
heet 2 of 2

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-938G2	Assembly - Diverter Valve - Right Hand	--
2	4012001-914G3	Valve Body - Phase III	1
3	4012153-339G5	Door - Forward	1
	4012054-580P21	Nut	2
4	4012153-338G4	Door - Aft	1
	4012054-580P21	Nut	2
5	4012090-894G1	Seal Segment	AR
6	4012153-371G3	Seal Segment, End	4
7	4012153-371G4	Seal Segment, End	4
8	4012153-372G1	Seal Tube	8
9	4012153-373P1	Seal Tube	4
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20	MS9033-12	Bolt	10
21	MS9033-10	Bolt	38
22	4012153-386P1	Spring	4

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
23	LHSS-16	Spherical Bearing	2
24	5000-175	Retaining Ring	2
25	R1068P1	Bolt	16
26	AN995N32	Lockwire	AR
27	841B660P1	Nut Strap	16
28	841B691P1	Support	4
29	841B653P1	Gasket	4
30	37R601158P121	Doubler Half	4
31	37R601158P129	Shell	1
32	37R601158P128	Nose	1
33	37R601158P120	Support Half	2
34	37R601158P114	Cover	1
35	37R601158P115	Deflector	1
36	37R601158P110	Strut Half	4
37	37R601158P111	Strut Half	2
38	37R601158P125	Doubler Half	4
39	Z1200-02	Nut	48
40	4012001-920P1	Bracket - Lifting	1
41	4012001-921G1	Bracket - Support	1
42	LSS4	Spherical Bearing	1
43			
44	AN960C10	Washer	21
45	12HR12-RB	Micro - Switch	3
46	H41-08	Nut	14

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
47	42H24097P2	Insulation Blanket	1
48	42H24097P4	Insulation Blanket	1
49	37B201596P101	Gasket	2
50			
51	4012001-936G4	Valve Div. Act. System Assembly	1
52			
53	HR-10033	Nut, Hex	6
54	HR-10030	Washer, Lock	6
55	8TE5AAK1	Thermocouple Harness - Right Hand	1
56	8TE5AAH1	Thermocouple Harness - Left Hand	1
57	37E501418P110	Duct - Leakage	2

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-936G4	Assembly - Actuation, Right	-
2	4012001-933G1	Assembly - Linkage Forward Door	-
3	4012153-374G1	Assembly - Linkage Rear Door	1
4	4012153-356P1	Torque Shaft	1
5	4012153-359P2	Clevis	1
6	4012153-360P1	Link	2
7	4012153-361P1	Clevis	1
8	4012153-362P1	Rod End	1
9	4012001-934G1	Actuator Support	1
10	4012090-898P1	Pin (0.375" Diameter)	4
11	4012090-897P1	Pin (0.4375" Diameter)	1
12	4012090-896P1	Pin (0.250" Diameter)	1
13	AN960C616L	Washer	10
14	AN960C10	Washer	AR
15	AN960C716L	Washer	2
16	AN960C416L	Washer	2
17			
18	4012001-939P1	Rod End	1
19	4012001-932P1	Actuator - Tandem	1
20	AN-381-3-16	Cotter Pin	8
21	MS20995C47	Lockwire	AR
22	4012153-381P2	Washer	AR
23	4012153-324P3	Bushing	4
24	4012153-331P1	Torque Plug	3

X353-5B PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
25	R108P20	Bolt	4
26	AN316C7	Nut	2
27	4012153-381P1	Washer	4
28			
29	4012001-933G2	Assembly - Linkage Forward Door	1
30	4012090-898P2	Pin (0.375" Diameter)	1
31	4012001-935P1	Pin (0.375" Diameter)	1
32			
33			
34	4012001-969P1	Torque Shaft	1
35	4012001-970P1	Shim	1
36	4012001-983P1	Sleeve	1

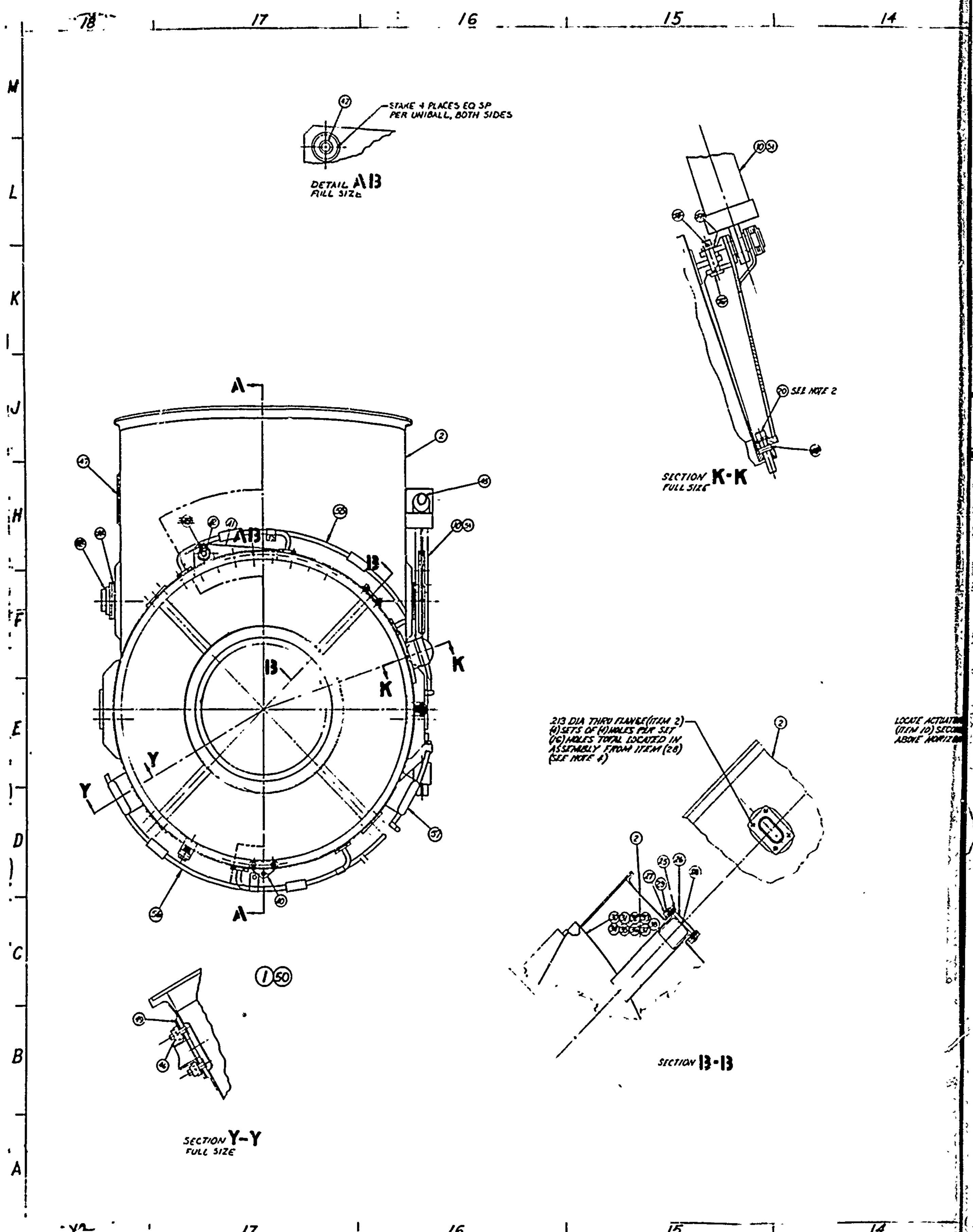
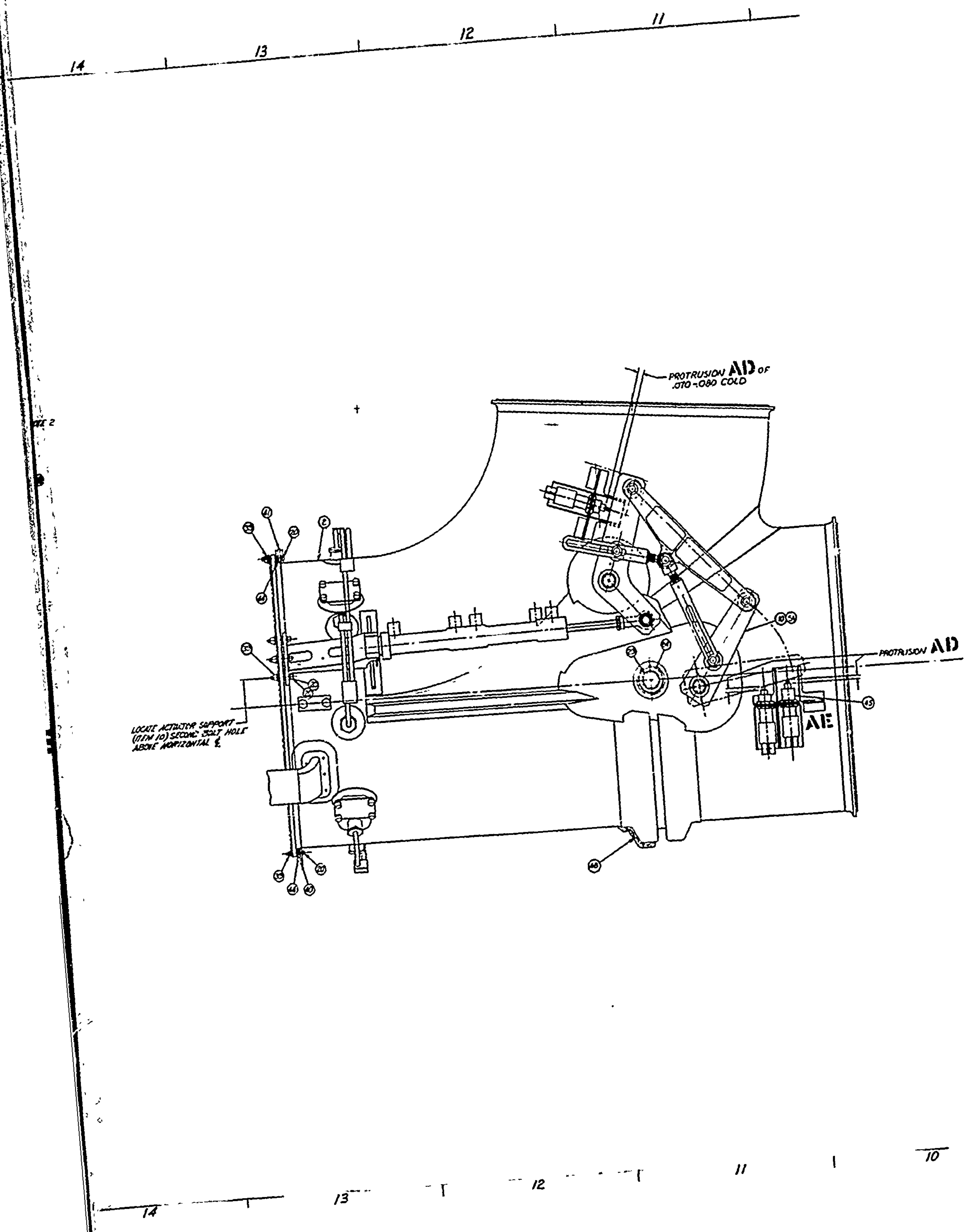


FIGURE 4.20A ASSEMBLY DRAWING, RIG DR
(4012001-938) Sheet -93

A



DRAWING, RIGHT HAND DIVERTER VALVE
-938) Sheet 1 of 2

B

I-4.131

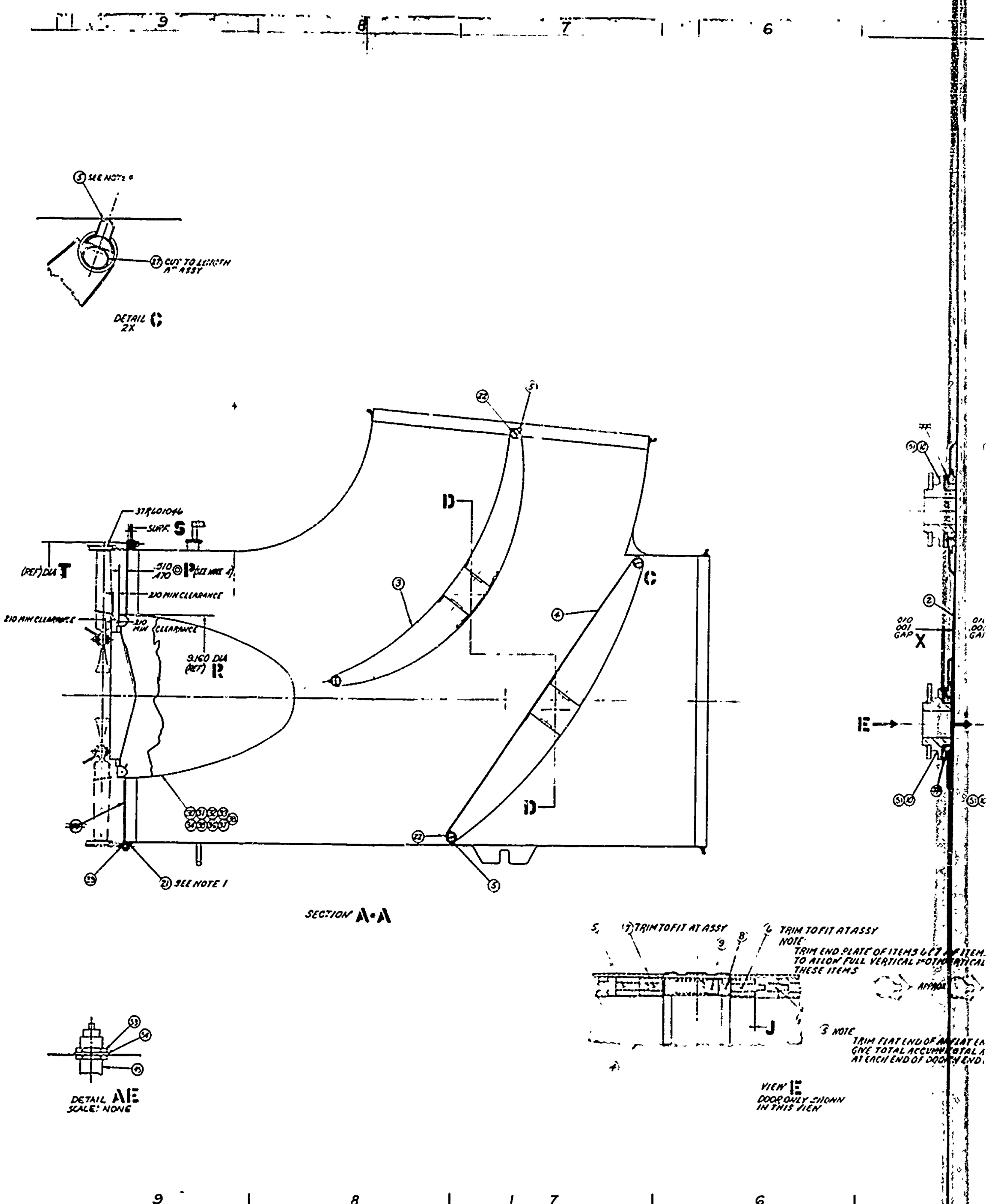


FIGURE 4.20A ASSEMBLY DRAW[...] DR
(4012001-938) -93

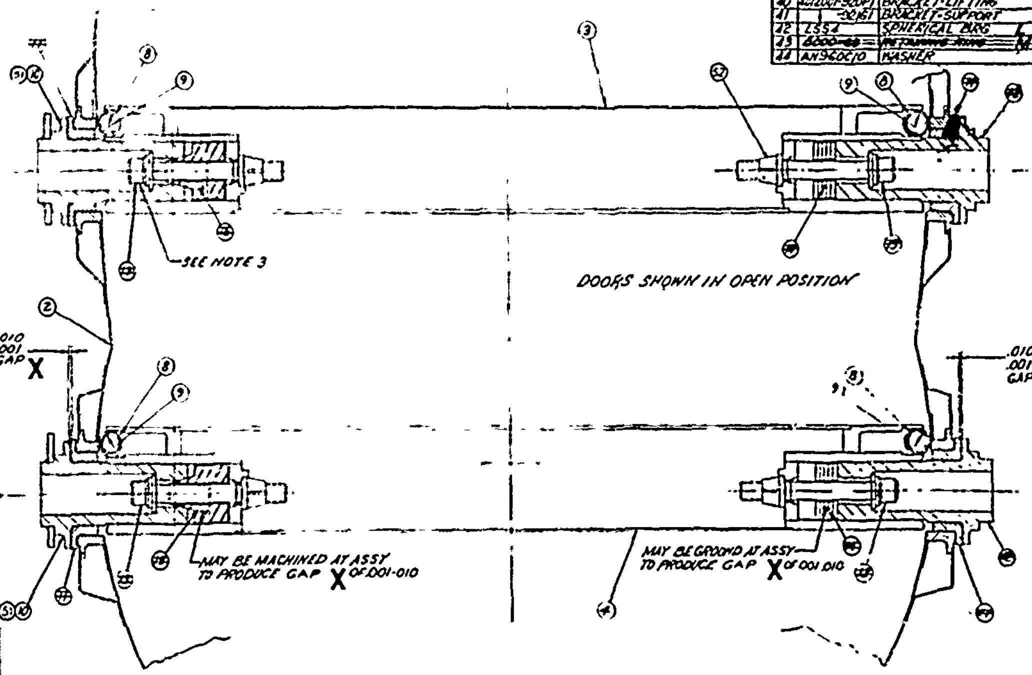
A

Item	Identification No.	Description or Name		Zone	Grp 1	Grp 2	Grp 3	Grp 4
45	12HF12 RB	MICRO SWITCH	U	E 10	3	3		
46	N41 CB	NUT	V	E 10	14	14		
47	42H24097P2	INSULATION BLANKET	W	H 12	1	1		
48	42H24097P4	INSULATION BLANKET	W	D 11	1	1		
49	37020155P01	GASKET	N	D 9	2	2		
50		ASSY		C-17	—	X		
51	4012001 3454	VALVE DIV ACT SYS ASSY		F-11	—	1		
52	4012054-580P2	NUT	AC	H 3	4	4		
53	NA40033	NUT, HEX	U	8-9	6	6		
54	NR-10230	WASHER LOCK	U	8-9	6	6		
55	6TEAAK1	T/C HARNESS	N	C-17	1	1		
56	6TEAAM1	T/C HARNESS	N	H 17	1	1		
57	37E2014 [illegible]	DUCT CLEARAGE	N	O-16	2	2		

Item	Identification No.	Description or Name		Zone	Grp 1	Grp 2	Grp 3	Grp 4
1		ASSY		C-17	X	—		
2	4065C1 3463	VALVE BODY-PHASE II		H-13	1	1		
3	40C153 3 [illegible]	DOOR-FWD		F-8	1	1		
4	[illegible]	DOOR-AFT		F-7	1	1		
5	40C030 5461	SEAL SEGMENT		C-3	AR	AR		
6	40C153 -3763	SEAL SEGMENT, END		C-6	4	4		
7	-3764	SEAL SEGMENT, END		C-7	4	4		
8	-3261	SEAL TUBE		F-5	8	8		
9	-3134	SEAL TUBE		F-5	4	4		
10	40C0A 93562	[illegible] DIVERTER ACT SYS ASSY		F-11	1	—		
11	[illegible]	[illegible]	F	D-2				
12	[illegible]	TORQUE SHAFT	F	[illegible]				
13	[illegible]	BOLT	F	F-5				
14	[illegible]	[illegible]	F	[illegible]				
15	[illegible]	TORQUE PLUG	F	D-5				
16	[illegible]	PIN (.250 DIA)	F	K-5				
17	[illegible]	[illegible]	F	[illegible]				
18	[illegible]	[illegible]	F	[illegible]				
19	[illegible]	[illegible]	F	[illegible]				
20	MS9033-12	BOLT		J-15	10	10		
21	MS9033-10	BOLT		C-9	33	30		
22	401153-3 [illegible]	SPRING		K-[illegible]	4	4		
23	LNSS-16	SPHERICAL BRG	L	F-11	2	2		
24	5000-775	RETAINING RING	M	F-11	2	2		
25	R10G8P1	BOLT		D-15	16	16		
26	MS9393 N32	LOCKWIRE		D-15	AR	AR		
27	[illegible]660P1	MT STRAP	N	D-15	16	16		
28	41IB691P1	SUPPORT	N	D-15	4	4		
29	41IB653P1	GASKET	N	D-15	4	4		
30	[illegible]P101	DOUBLER HALF	N	D-[illegible]	4	4		
31	P109	SHELL	N	D-3	1	1		
32	P108	NOSE	N	D-3	1	1		
33	P120	SUPPORT HALF	N	D-3	2	2		
34	P114	COVER	N	D-3	1	1		
35	P115	DEFLECTOR	N	D-3	1	1		
36	P110	STRUT HALF	N	D-3	4	4		
37	P111	STRUT HALF	N	D-3	2	2		
38	P105	DOUBLER HALF	N	D-3	4	4		
39	21200-02	NUT	H	C-9	48	48		
40	4012001-920P1	BRACKET-LIFTING		C-17	1	1		
41	-921P1	BRACKET-SUPPORT		H-17	1	1		
42	LSS4	SPHERICAL BRG	L	[illegible]	1	1		
43	5000-[illegible]	RETAINING RING	M	[illegible]	2	2		
44	AN960C10	WASHER		[illegible]	21	21		

Sym	Revisions
1	GENCHG PERM RECORD REPRODUCIBLE FILED PA-001-938-1
B	GENCHG PERM RECORD REPRODUCIBLE FILED DCID 1460141 & 146026

~~R FOR REF ONLY (SEE 4012001-936)~~
H ELASTIC STOPNUT CORP. UNION N.J. OR EQUIV
L THE HEIM CO. FAIRFIELD CONN. OR EQUIV.
M WALDES KOHINOOR INC. LONG ISLAND CITY, N.Y. OR EQUIV
N (REF.) STANDARD J-65 PARTS
U MINNEAPOLIS HONEYWELL MICRO-SWITCH DIV FREEPORT, ILL.
V KAYNAR MFG CO. FULLERTON CALIF.
W H.I. THOMPSON GARDENA, CALIF.
AC REF DWGS 4012153 338 & 4012153-339



SECTION D-D
1/1

ITEMS 6 & 7 AS HLOD
[...]TICAL MOTION OF
APPROX TRIM LINES
[...]AT END OF ANT SEAL PIECE TO
[...]OTAL ACCUMULATED GAP J OF .050-.060
[...] END OF DOOR

7 PLUNGER ON ITEM 45 TO BE LUBRICATED WITH MOLLY DISULFIDE AT ASSY & AFTER EACH 5 HRS OF OPERATION
6 SEALS SHOULD BE COMPRESSED SLIGHTLY AGAINST THE WALL, BUT SHOULD BE FREE TO FLOAT IN THE FULL CLOSED POSITION FOR THE BEST SEALING RESULTS
5 THIS SYMBOL Ⓢ DENOTES A DIMENSION OF PRIMARY IMPORTANCE
4 WITH DIA T AND SURF. S RESTRAINED TO WITHIN DRAWING TOLERANCES (REF DWG. 4012001-314), THE FOLLOWING DIMENSIONS AND CONDITIONS ARE TO BE MET:
a) DIM. P TO BE MET WITH CENTER CONE IN ITS FORWARD POSITION
b) DIA R TO BE CONCENTRIC WITH DIA T WITHIN .030 FULL INDICATOR READING
3 TORQUE BOLTS TO 160 IN LBS
2 TORQUE ITEM 20 TO 40 IN LBS
1 TORQUE ITEM 21 TO 40 IN LBS
— USE CRANE COMPOUND OR EQUIV UNDER HEAD OF BOLT & NUT & ON SCREW THDS

PRODUCT MUST CONFORM TO THE ABOVE NOTES

ASSEMBLY-
DIVERTER VALVE,
RIGHT HAND

GENERAL ELECTRIC
EVENDALE PLANT
R 4012001-938
SCALE 1/2

DRAWING, RIGHT HAND DIVERTER VALVE
-938) Sheet 2 of 2

B

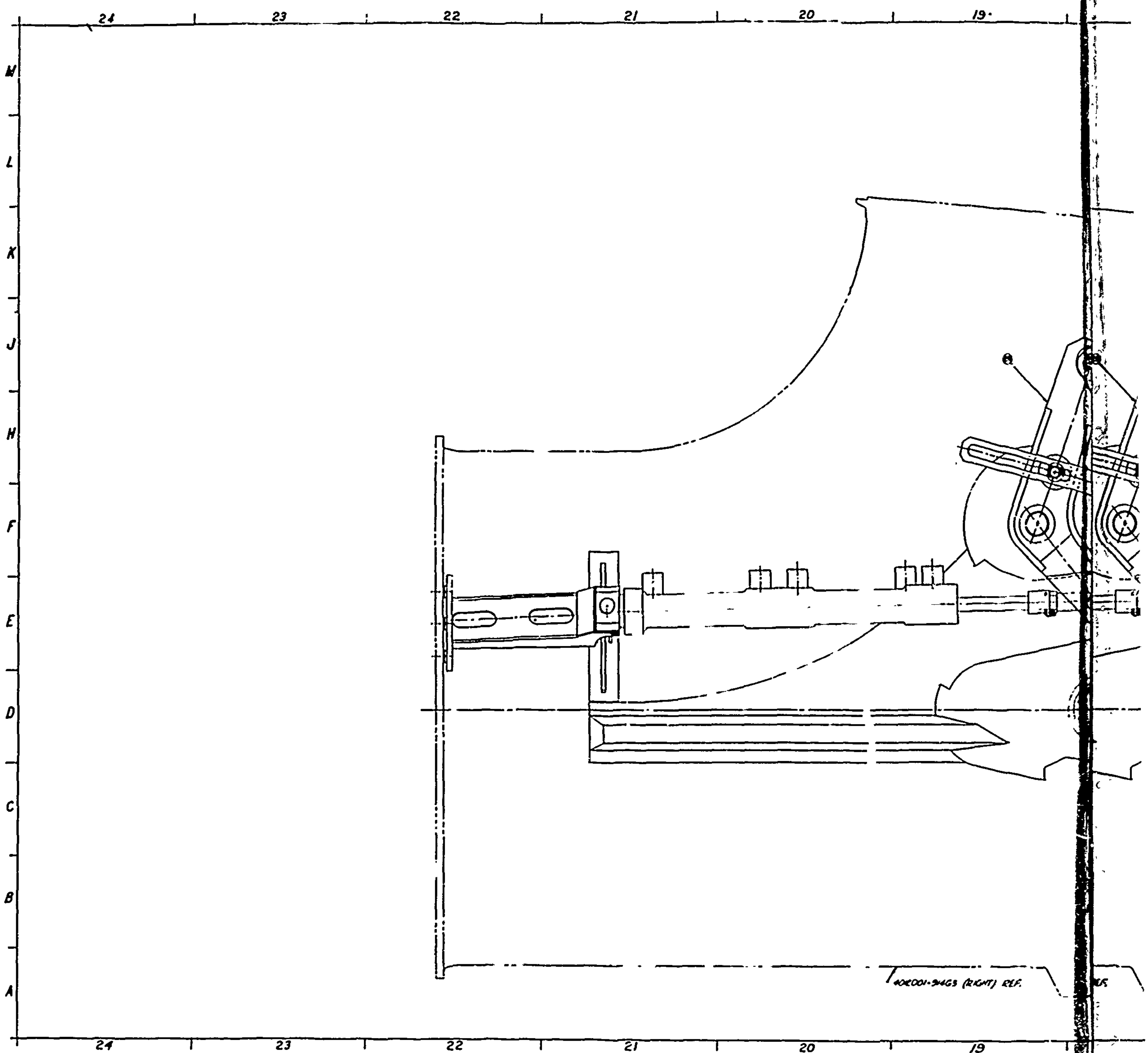
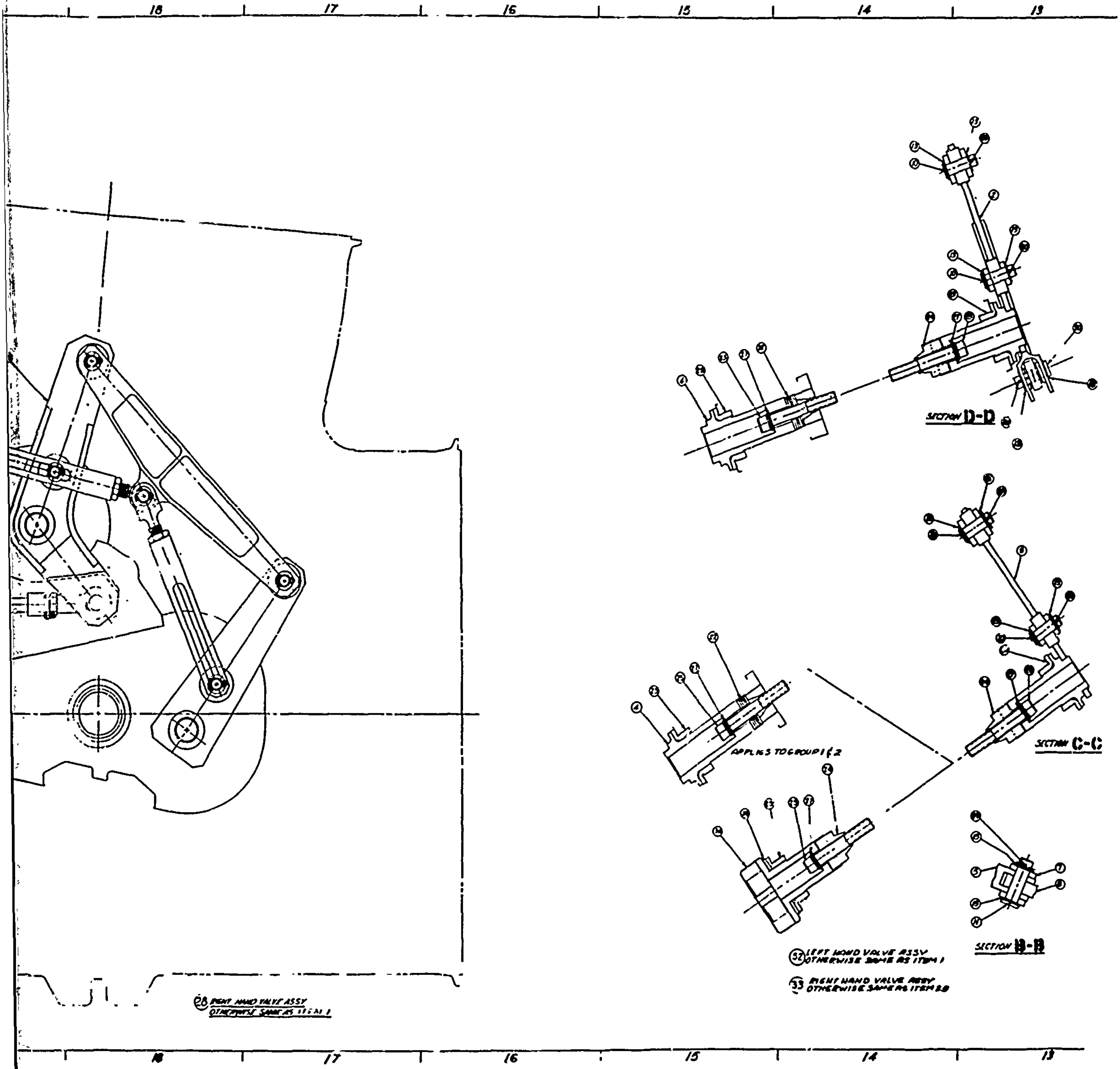


FIGURE 4.21 ASSEMBLY DRAWING, [illegible]ING,
(4012001-936) Shee[illegible] She[illegible]

A



NG, DIVERTER VALVE ACTUATION SYSTEM
Sheet 1 of 2

B

I-4.133

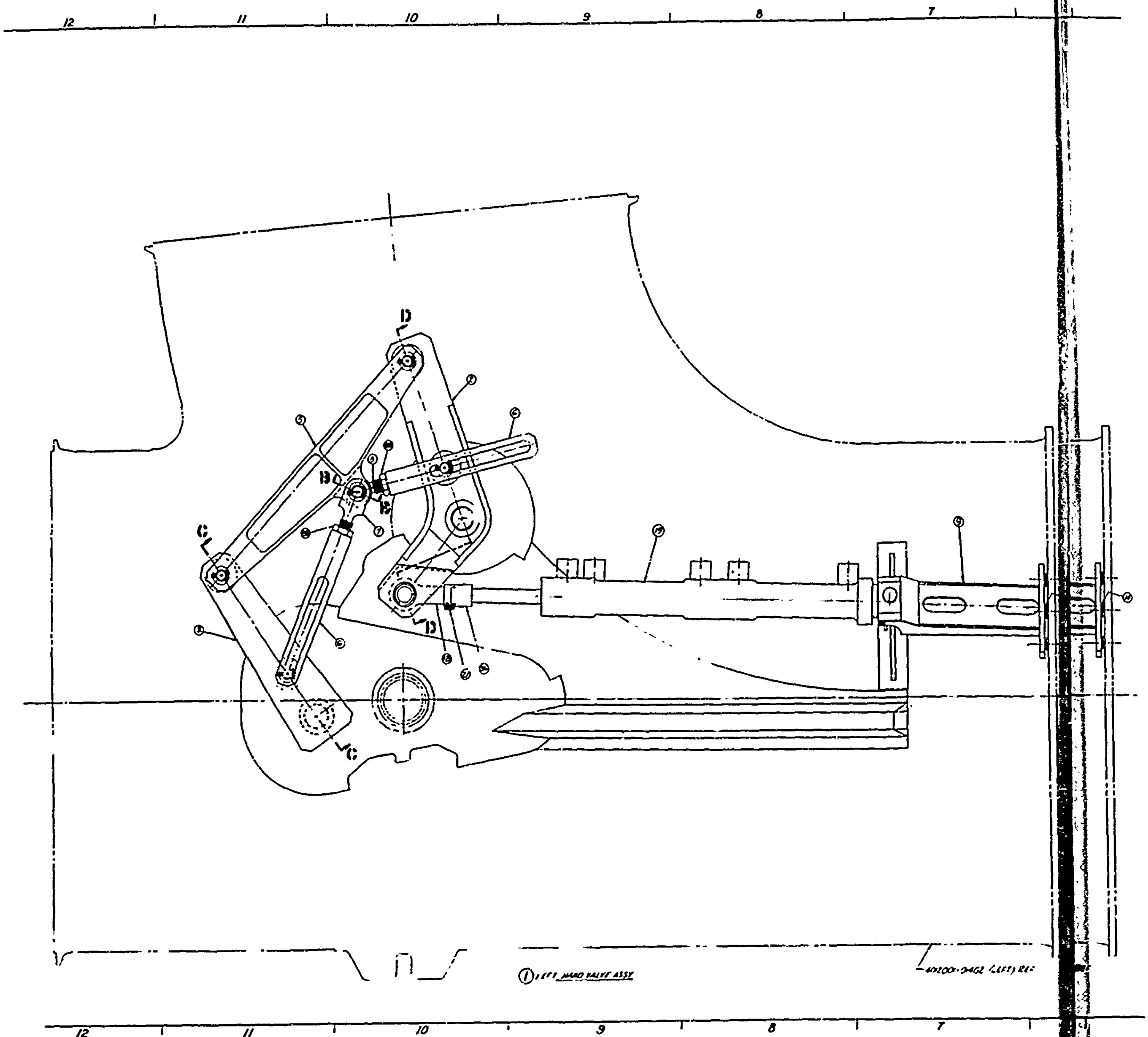
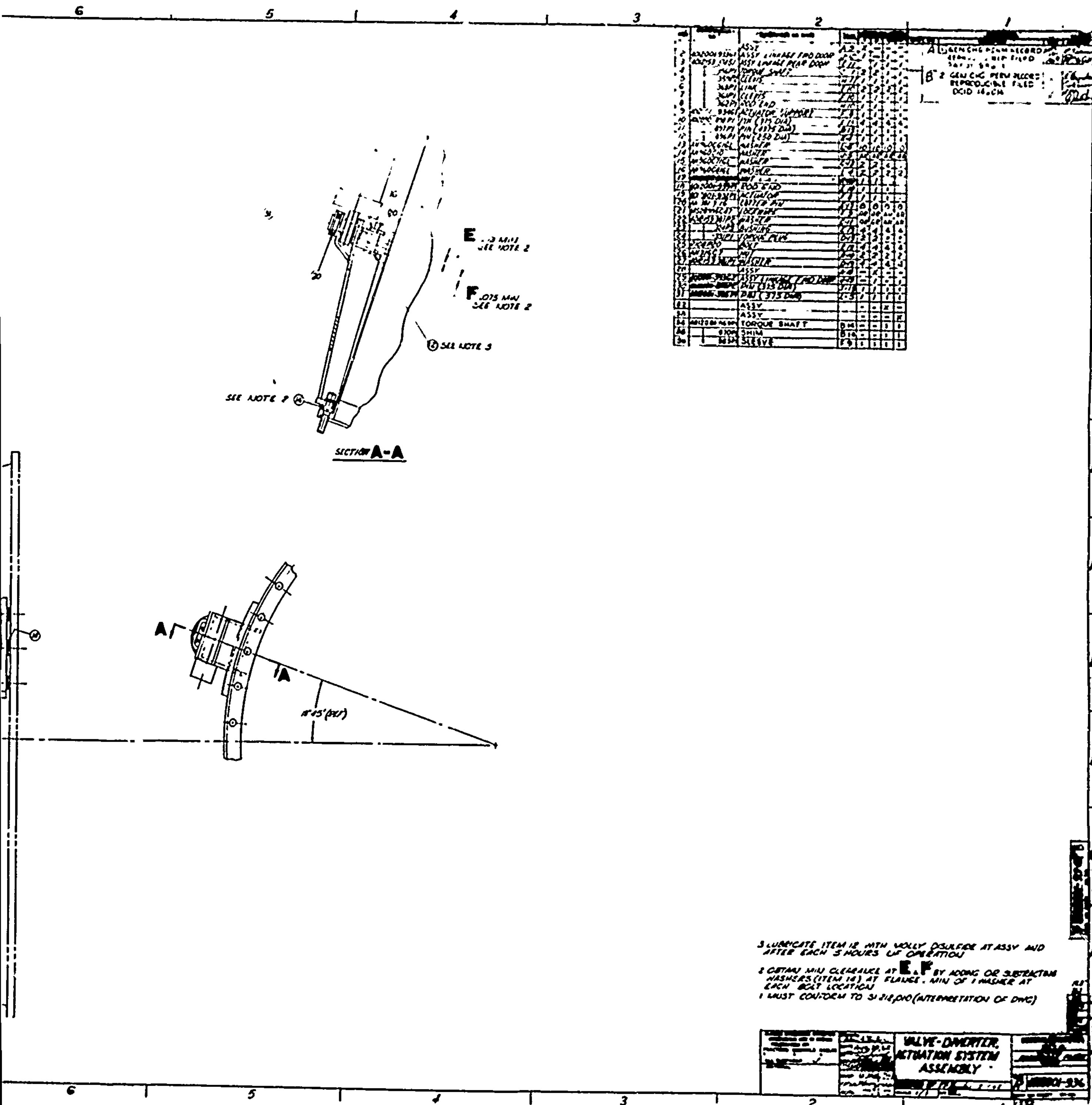


FIGURE 4.21 ASSEMBLY DRAWING, DIVERTER
(4012001-936) Sheet 2 of 2 of

A



ERTER VALVE ACTUATION SYSTEM
of 2

B

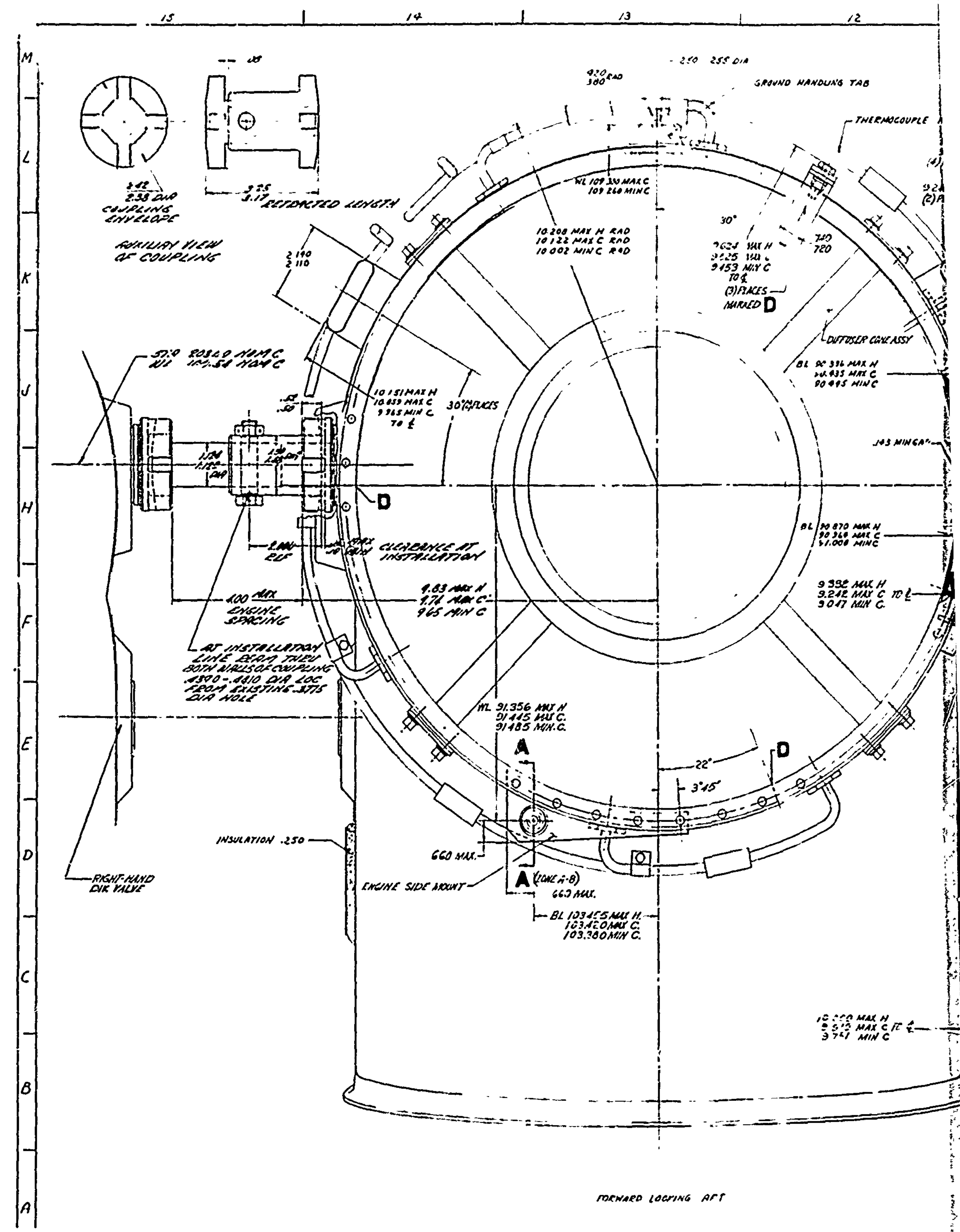
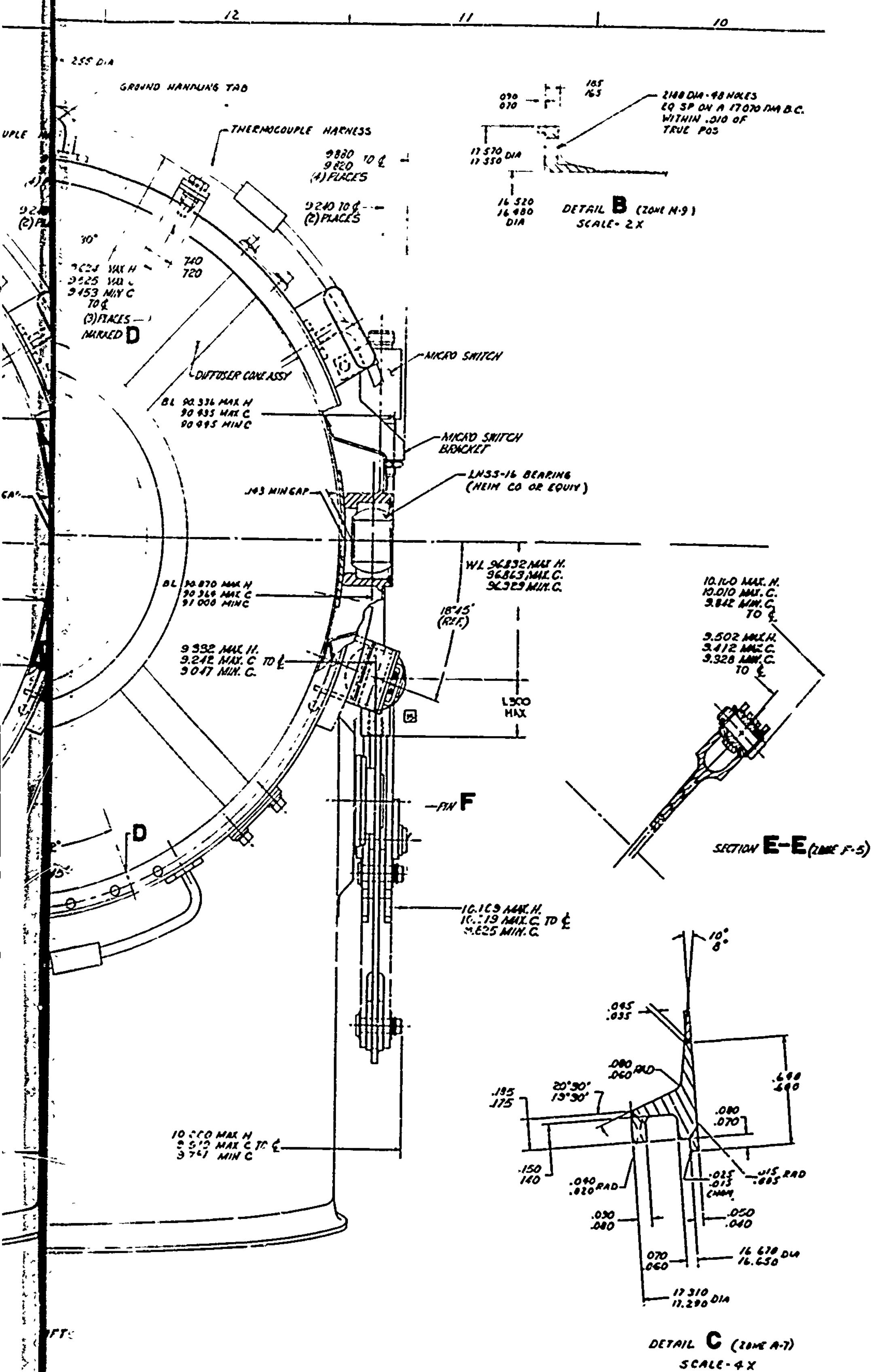


FIGURE 4.21A X353-5B DIVERTER VALVE INSTALL
(4012001-912) Sheet 1 of 2



DIVERTER VALVE INSTALLATION
-912) Sheet 1 of 2

-4.135

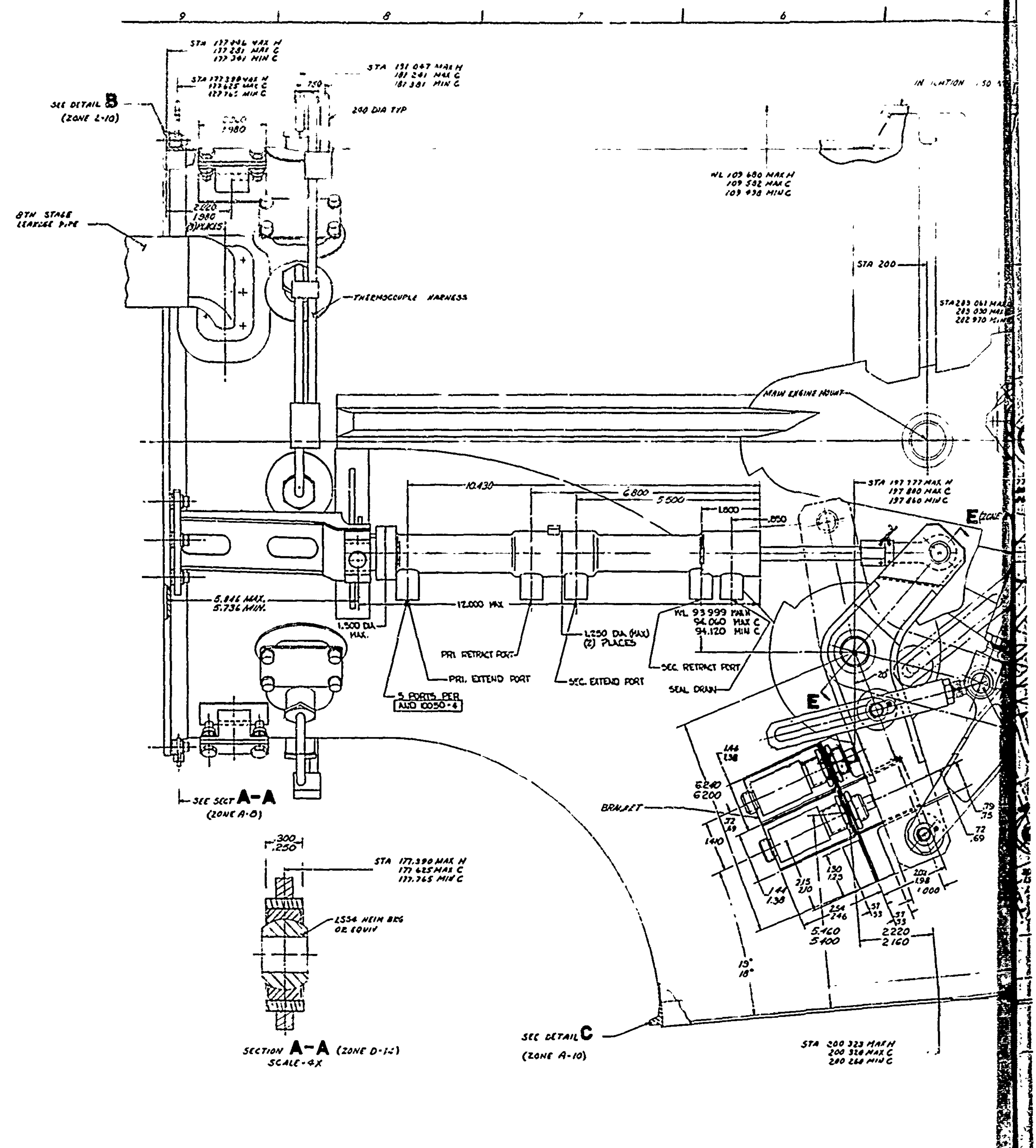
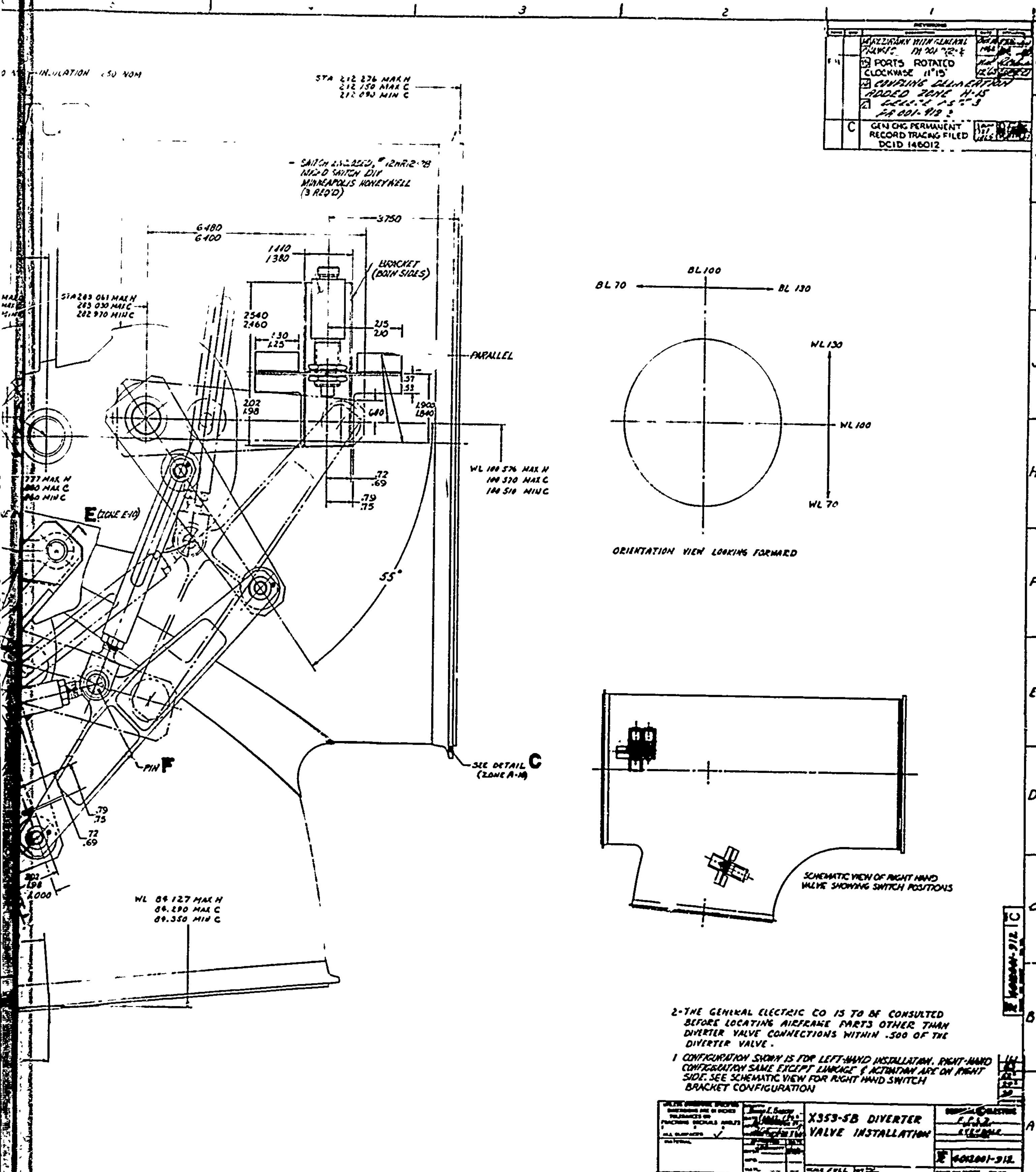


FIGURE 4.21A X353-5B DIVERT[illegible]
(4012001-912) [illegible]

A



DIVERTER VALVE INSTALLATION
(…1-912) Sheet 2 of 2

B

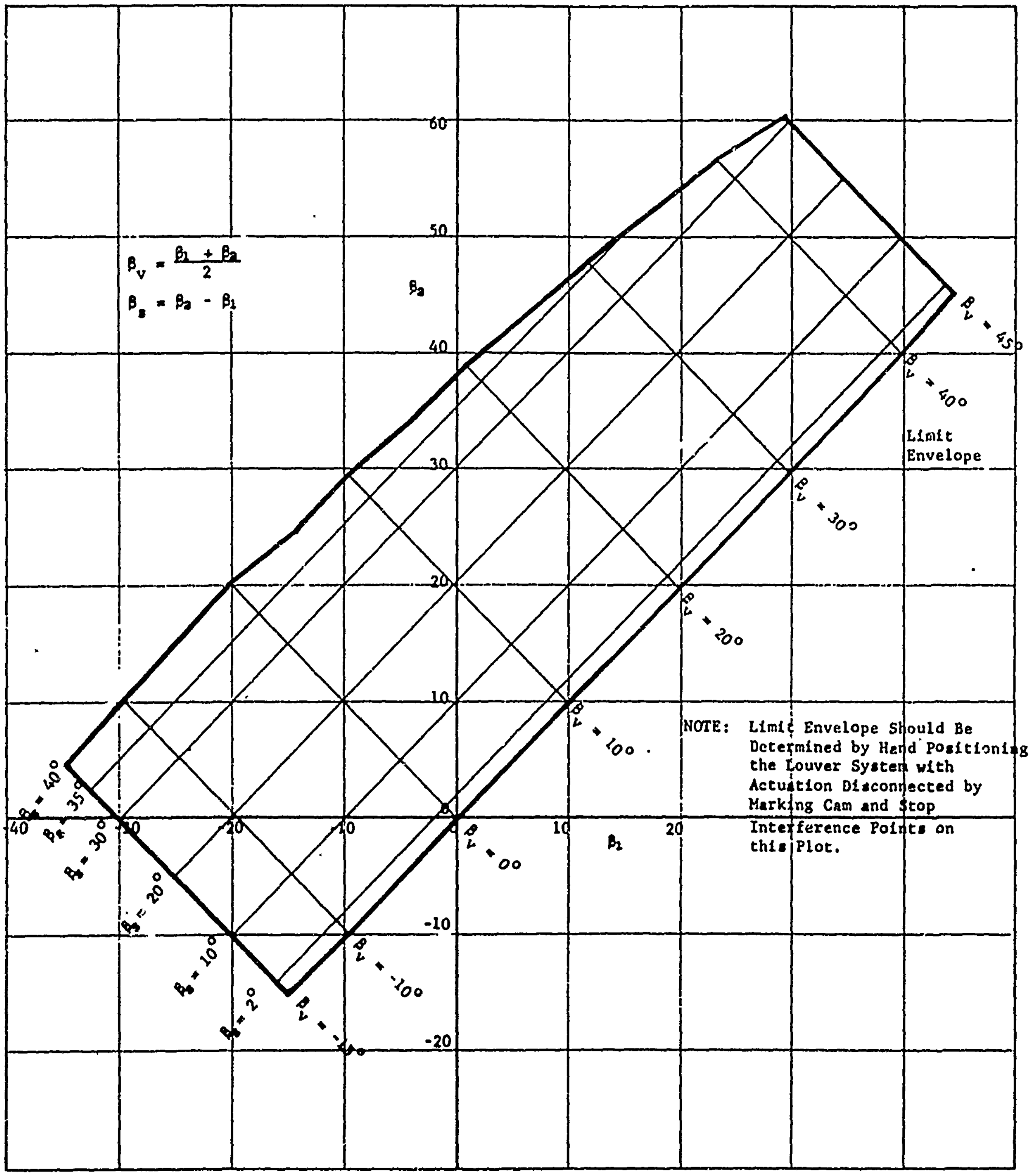


FIGURE 4.23 - EXIT LOUVER ACTUATION LIMITS

ITEM	IDENTIFICATION	ZONE	DESCRIPTION	REF	GROUP NO 1 QTY	2	3	4	REMARKS
3	4012001-958G[illegible]	10	DIVERTER VALVE RH		1				
	4012153-914G[illegible]		VALVE BODY-FWD [illegible]		1				
	[illegible]		[illegible]		1				
	[illegible]		[illegible]		1				
	42H24097P2		INSULATION BLANKET	H	1				
	42H24097P4		INSULATION BLANKET	H	1				
4	4012001-964P1	E8	HUB COUPLING		1				
5	4012001-966P1	E8	HUB COUPLING		1				
6	4012001-973P1	D8	BOLT		1				
7	4012153-274P9	E8	NUT		1				

ITEM	IDENTIFICATION	ZONE	DESCRIPTION
	L554		SPHERICAL BRG
	AN960C10		WASHER
	12HR12-RB		MICRO-SWITCH
	H41-08		NUT
	42H24097P3		INSULATION BLANKET
	42H24097P5		INSULATION BLANKET
	37B201596P6		GASKET
	HR10238		NUT, HEX
	HE10730		WASHER, [illegible]
	4012001-956G[illegible]		[illegible]
	4012001-933G1		[illegible]
	4012153-3[illegible]G[illegible]		[illegible]
	4012153-336P1		TORQUE SHAFT
	359P2		CLEVIS
	-360P1		LINK
	-361P1		CLEVIS
	4012153-362P1		ROD END
	4012001-934G1		ACTUATOR SUPPORT
	4012030-[illegible]		PIN (.375 DIA)
	4012030-[illegible]		PIN (.4375 DIA)
	4012030-[illegible]		PIN (.250 DIA)
	AN960C616L		WASHER
	AN960C10		WASHER
	AN960C716L		WASHER
	AN960C416L		WASHER
	4012001-935P1		ROD END
	4012001-932P1		ACTUATOR
	AN 381-3-16		COTTER PIN
	MS20995C47		LOCKWIRE
	4012153-381P2		WASHER
	4012153-324P[illegible]		BUSHING
	4012153-331P1		TORQUE PLUG
	R108P20		BOLT
	AN316C7		NUT
	4012153-381P1		WASHER
	4012030-0[illegible]P2		PIN (.875 DIA)
	4012001-935P1		PIN (.375 DIA)
	[illegible]P1		TORQUE SHAFT
	-970P1		SHIM
	4012001-980P1		SLEEVE

* 2 EACH FWD DOOR, 1 ON AFT DOOR
2 EACH AFT DOOR, 1 ON FWD DOOR

ITEM	SOURCE
A	CHERRY RIVET DIV TOWNSEND CO SANTA ANNA, CALIF
B	THE HEIM CO FAIRFIELD CONN OR EQUIV
C	WALDES KOHINOOR INC LONG ISLAND CITY, N.Y. OR EQUIV
D	STANDARD J-85 PARTS LYNN RIVER WORKS
E	ELASTIC STOPNUT CORP UNION, N.J. OR EQUIV
F	MINNEAPOLIS HONEYWELL MICRO-SWITCH DIV FREEPORT ILL
G	KAYNAR MFG CO. FULLERTON CALIF
H	H.L. THOMPSON GARDENA, CALIF

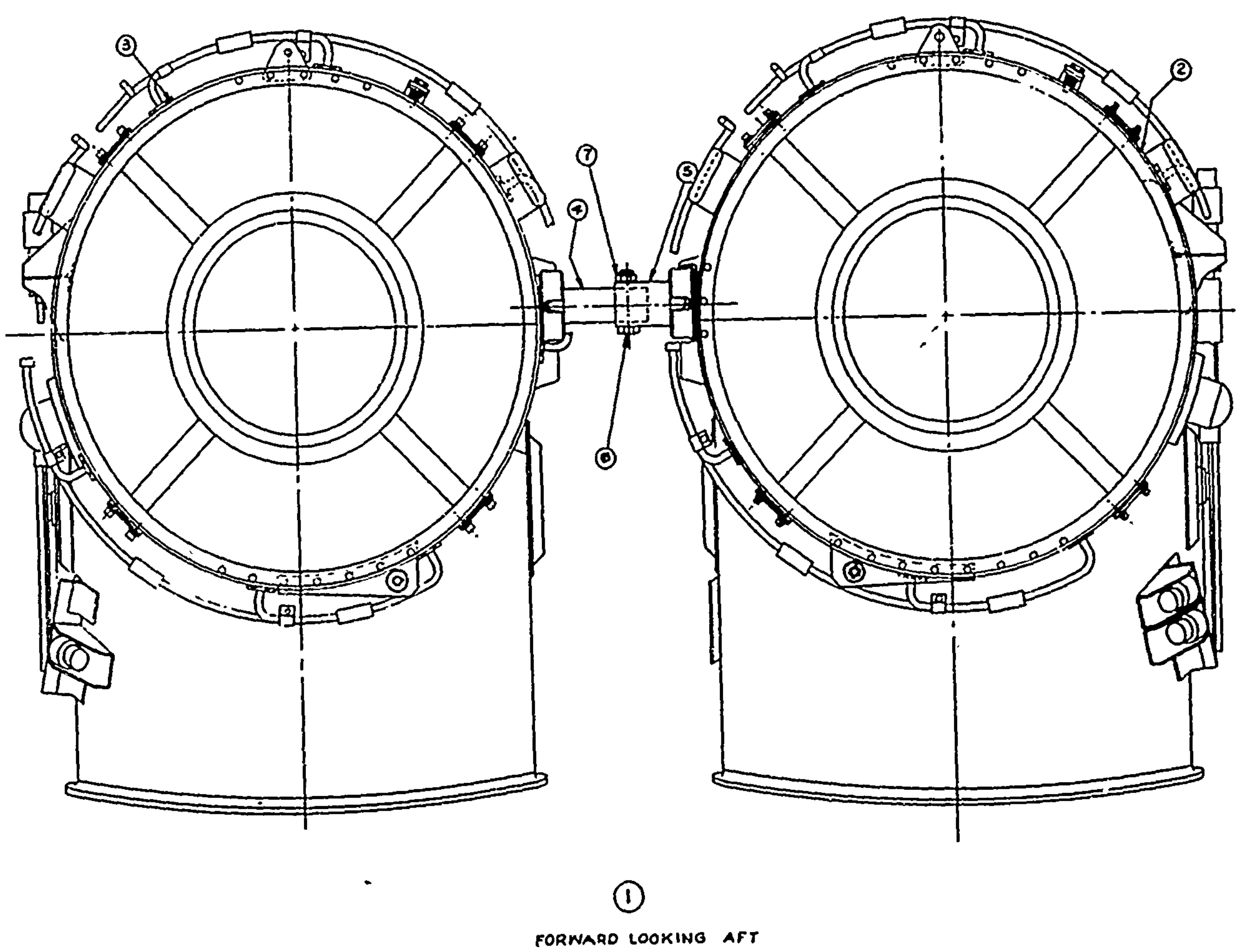


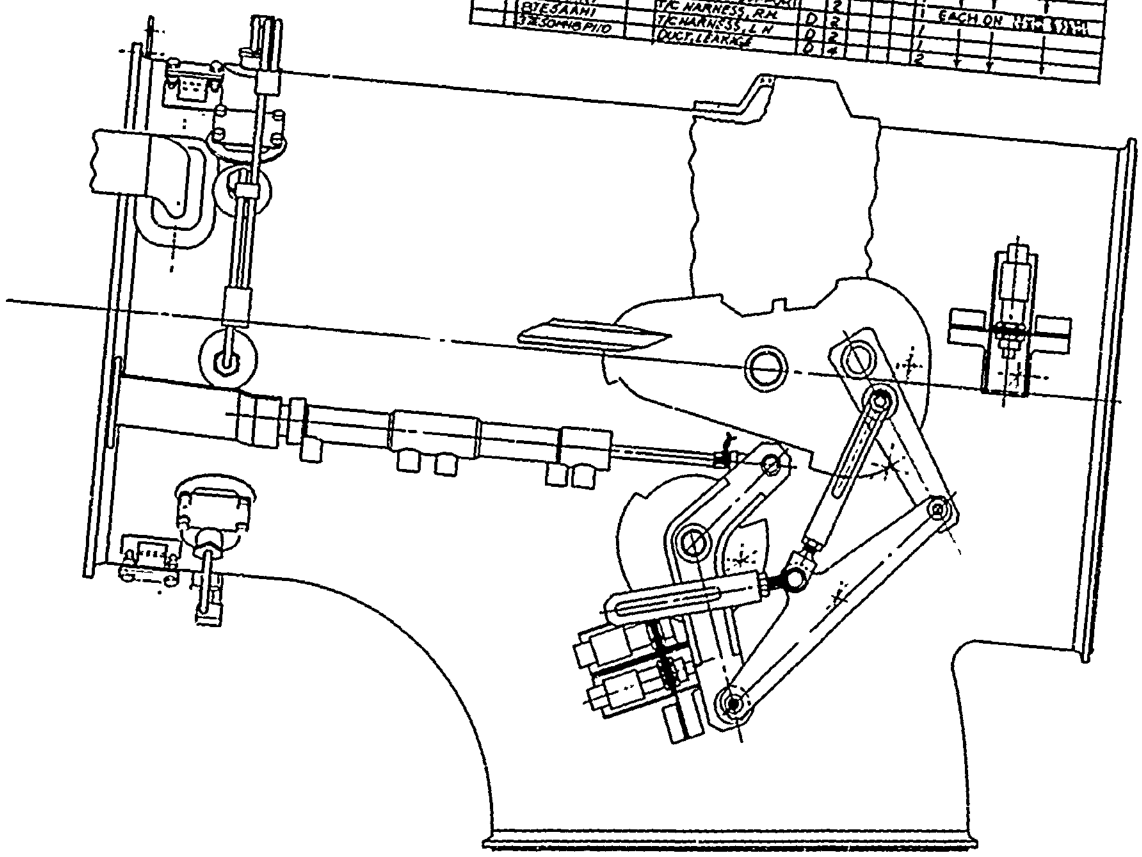
Figure 4.24 ASSEMBLY DRAWING, COU[illegible]
(4012001-915)

A

IDENTIFICATION	ZONE	DESCRIPTION	REF	GROUP NO / QTY 1	2	3	4	REMARKS
...4		SPHERICAL BRG	B	2				
...60C10		WASHER						1 EACH ON [illegible]
...12-RB		MICRO-SWITCH		42				
...08		NUT	F	6				21 EACH ON [illegible] * SEE ZONE F6
...4097P6		INSULATION BLANKET	G	20				
...4097P5		INSULATION BLANKET	H	1				14 EACH ON [illegible]
...01596P6		GASKET	H	1				
...339		NUT, HEX	D	4				
...330		WASHER ...	F	12				2 EACH ON [illegible]
			E	12				6
...01-936G3		VALVE DIVERTER ASY						6
...001353G1		[illegible]		1				
...153314G1		[illegible]		1				
...153 336P1		[illegible]		1				
...559P2		TORQUE SHAFT		2				1 EACH ON [illegible]
...560P1		CLEVIS		2			1	
...561P1		LINK		2			1	
...152-362P1		CLEVIS		4			2	
...001-934G1		ROD END		2			1	
...020-836P1		ACTUATOR SUPPORT		2			1	
...090-A37P1		PIN (.375 DIA)		2			1	
...090-836P1		PIN (.4375 DIA)		8			4	
...60C616L		PIN (.250 DIA)		2			1	
...60C10		WASHER		2			1	
...60C716L		WASHER		20			10	
...60C416L		WASHER		AR			AR	
...001933P1		WASHER		4			2	
...001-932P1		ROD END		4			2	
...4848-16		ACTUATOR		2			1	
...N95C 7		COTTER PIN		2			1	
...63 581P2		LOCKWIRE		16			8	
...53 584P1		WASHER		AR			AR	
...155-321P1		BUSHING		AR			AR	
...020		TORQUE PLUG		8			4	
...16C7		BOLT		6			8	
...63 581P1		NUT		8			4	
...110-092P2		WASHER		4			2	
...551-335P1		PIN (.875 DIA)		8			4	
[illegible]		PIN (.376 DIA)		2			1	
...370P1		TORQUE SHAFT		2			1	
...41-960P1		SHIM		2			1	
		SLEEVE		2			1	1 EACH ON [illegible]

1 EACH FWD DOOR, 1 ON AFT DOOR L.H.
2 EACH AFT DOOR, 1 ON FWD DOOR R.H.

ITEM	IDENTIFICATION	ZONE	DESCRIPTION	REF	GROUP NO / QTY 1	2	3	4	REMARKS
1									
2	4012001-937G2	B6	ASSY		X				
	4012001-914G2	E6	DIVERTER VALVE, LH		1				
	378301514P101		VALVE BODY PHASE III		1				
	4012001-927G1		BOLT, FH		1				
	Z1855-[illegible]		[illegible]	D	20				
	71CB11C		NUT, DBL HEX		2	H			14 EACH ON [illegible]
	4012001-327P1		BOLT, .250-28NS	E	12			1	
	4012001-327P1		COVER		12			6	
			GASKET		6			6	
	4012153-338G3				6			3	
	4012153-339G4		DOOR, AFT					3	
	CR6636-6-4		DOOR FWD.		2			1	
	4012054-382		RIVET .093 DIA.		2			1	
			NUT	A	20			10	
	4012090-894G1				8			4	
	4012155-311G2		SEAL SEGMENT		AR			AR	
	4012090-894G1		SEAL SEGMENT END		8			4	
			SEAL SEGMENT		8			4	
	4012155-371G4		SEAL SEGMENT END						
	-372G1		SEAL TUBE		8			4	
	-373P1		SEAL TUBE		16			8	
	MS 9088-12		BOLT		8			4	
	MS 9088-10		BOLT		20			10	
	4012153-386P1		SPRING		76			38	
	LH 33-16		SPHERICAL BRG		8			4	
	5000-175		RETAINING RING	B	4			2	
	R1068P1		BOLT	C	4			2	
	AN935N32		LOCKWIRE		32			16	
	8418660P1		NUT STRAP		AR			AR	
	8418691P1		SUPPORT	D	32			16	
	8418685P1		GASKET		8			4	
	37R601168P101		DOUBLER HALF		8			4	
	P107		SHELL		8			4	
	P108		NOSE		2			1	
	P109		SUPPORT HALF		2			1	
	P114		COVER		4			2	
	P115		DEFLECTOR		2			1	
	P110		STRUT HALF		2			1	
	P111		STRUT HALF		8			4	
	37R601158P1[illegible]		DOUBLER HALF		4			2	
	Z1200-02		NUT	D	8			4	
	4012001-920P1		BRACKET-LIFTING	E	96			48	
	4012001-921G1		BRACKET SUPPORT		2			1	
	8TE5AAK1		T/C HARNESS, R.H.		2			1	1 EACH ON [illegible]
	8TE5AAH1		T/C HARNESS, L.H.	D	2			1	
	3730M16P110		DUCT, LEAKAGE	D	2			1	
				D	4			2	



1 MUST CONFORM TO S1212010 (INTERPRETATION OF DWG)

DWG TYPE ASSEMBLY

GENERAL ELECTRIC

ASSY-DIVERTER VALVES, COUPLED

J 4012001-915

...LY DRAWING, COUPLED DIVERTER VALVES
(...001-915)

SECTION 5.

INSTALLATION

5.1 INSTALLATION PROCEDURE

The procedures for installation of the XV-5A propulsion system in the XV-5A aircraft is to be provided by the airframe manufacturer.

5.2 Installation Design Data

All installation design data is provided in the XV-5A Specification #112.

5.3 INSTRUMENTATION

5.4 Diverter Valve

The diverter valve incorporates three position switches to indicate diverted or straight-through flow positions of the doors. The circuit diagram is shown in Figure 5.1.

5.5 Lift Fan Permanent Instrumentation

a. Permanent instrumentation on the lift fan includes:

1. Fan rpm
2. Exit louver vector angle } aircraft - supplied
3. Exit louver stagger angle
4. Fan bearing temperature (2 per fan)

b. The fan rpm sensor is a magnetic reluctance pickup mounted in the hub of the fan. The sensor provides cockpit readout of rotor rpm. For initial flight testing, the output from this sensor can be used to provide overspeed warning and speed cut-back trip functions when integrated into an electro-mechanical system within the throttle linkage mechanism between the cockpit throttles and the engine fuel control (see Figure 5.2),

c. The fan rpm electronics package requires 24 - 28V DC power and will draw 2 amps in the indicating mode and 7 - 10 amps in the tripped mode.

d. The rpm warning indication will occur nominally at 100%(± 1/2)% fan rpm and may be internally adjusted between 95% and 105% rpm. The overspeed trip system provided for initial flight testing is set to function at 103%(± 1/2)% rpm and may be internally adjusted between 100% and 110% rpm.

e. The electronics package (Figure 5.3) is provided with the lift fans but is mounted to the airframe. Lead wire connecting and fan speed sensor with the electronics package is provided by the airframe manufacturer and should be two-wire, #16 size, in a single #30 shielded cable.

f. Airframe furnished read-out instruments should be electrically similar to the General Electric Model DB-18 or a Weston Model MS 33550. Use the other type instruments should be coordinated with General Electric prior to final selection. Basic meter movement required is 0 to 200 microamperes.

g. Installation adjustment of the entire rpm indicating and limiting system should utilize the following procedure (refer to Figure 5.3).

Equipment Required:

1. Precision laboratory oscillator; 500 to 5000 cps; 1 volt rms output.
2. Volt-ohm-milliammeter; 20,000 ohms/volt.

Adjustment Procedure:

* With system energized at zero fan rpm, adjust mechanical zero adjustment of each rpm indicator to read zero.
* Connect precision oscillator to test points marked "OSC" and "GRD" on Converter Card No. 1. Oscillator output should be 1 volt or greater.
* Set frequency equal to 100% rpm; 4074 cps for pitch fan (2640 for lift fans on Converter Cards Nos. 2 and 3.)
* Connect positive terminal of V.O.M. to test point on Trip Point Card No. 1 marked "WARNING". Connect negative terminal of V.O.M. to test point "GRD" also of Trip Point Card No. 1.
* Adjust "RANGE" potentiometer of Converter Card No. 1 until V.O.M. just indicates a positive 5 volt deflection. This switching action is 100% rpm warning function.
* Adjust "METER" potentiometer of Trip Point Card No. 1 until the rpm indicator shows 100% rpm.
* Increase oscillator frequency to the value corresponding to power cut-back rpm.
* Connect V.O.M. positive terminal to test point marked "PWR CUTBACK" of Trip Point Card No. 1.
* Adjust the "PWR CUTBACK" potentiometer of Trip Point Card No. 1 until V.O.M. just indicates a positive 5 volt deflection. This switching action is the power cut-back function.
* Repeat above steps to eliminate interaction of adjustments.
* Repeat entire procedure for other two channels.

h. One vibration pickup, a Consolidated Electro-Dynamics CEC 4-122A (reading bulletnose vertical vibration), is mounted in the hub structure of the lift fan.

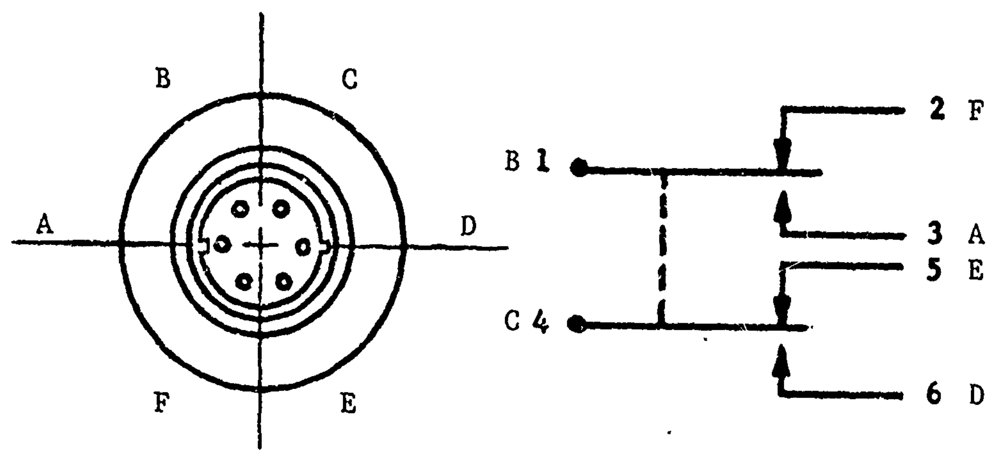


FIGURE 5.1 DIVERTER VALVE LIMIT SWITCH CIRCUIT DIAGRAM

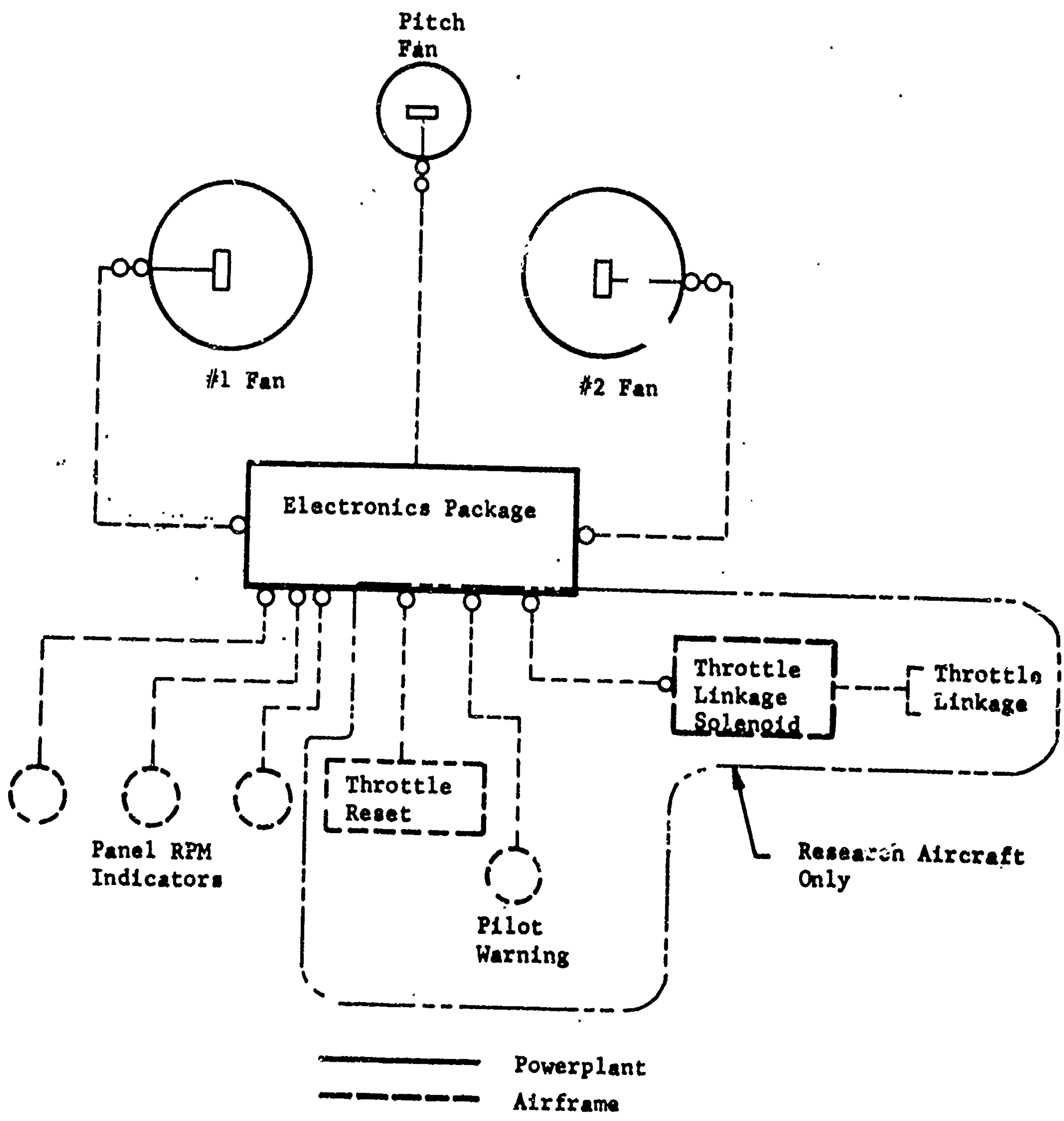


FIGURE 5.2 X353-5B RPM INDICATING AND OVERSPEED LIMITING SYSTEM ELECTRONICS COMPONENT

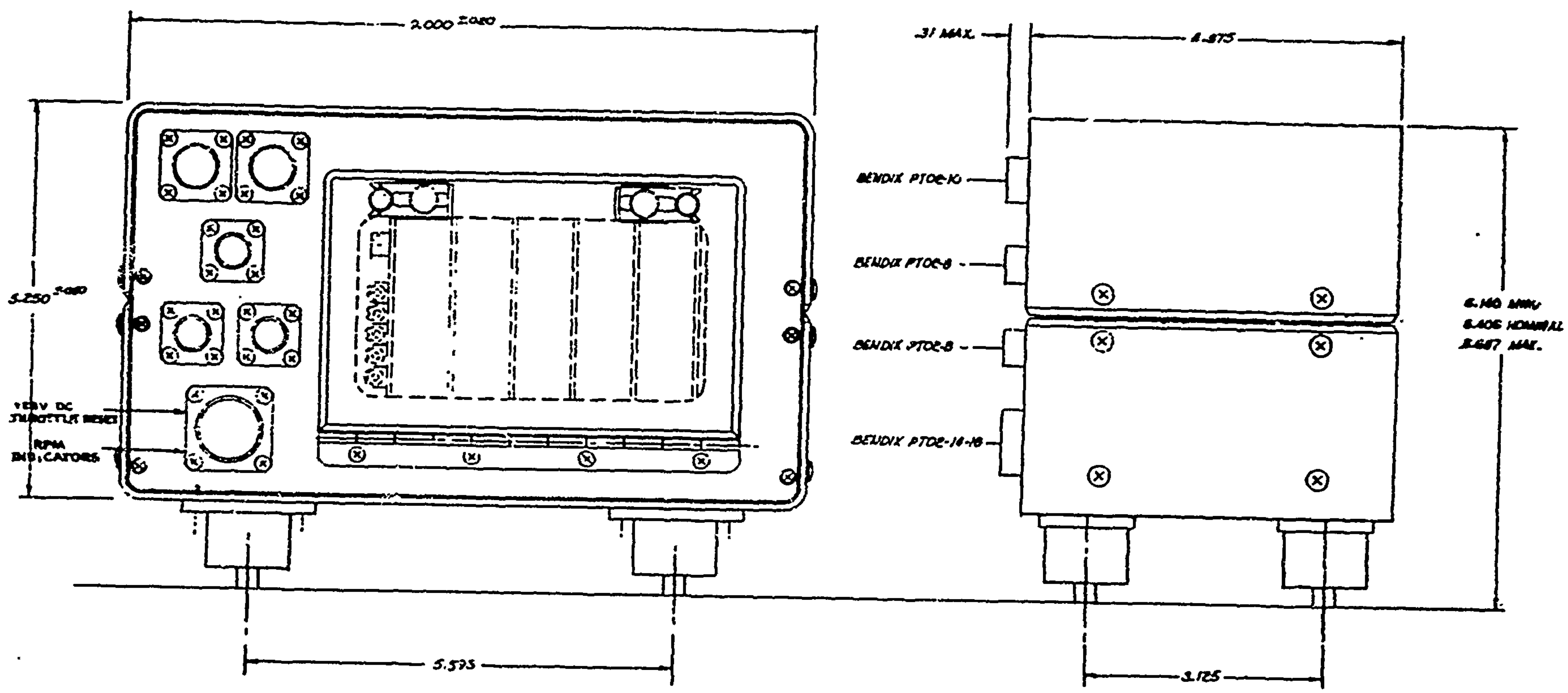


FIGURE 5.3 **RPM INDICATING AND LIMITING SYSTEM -- MODEL AC-106 ELECTRONICS PACKAGE**

SECTION 6.

X353-5B LIFT FAN DISASSEMBLY

6.1 PREPARATION FOR TEARDOWN

a. Remove the lift fan from the shipping container and position it in the lift fan build-up dolly (Par. 3.7).

6.2 REMOVE REAR FRAME

a. Place the lift fan in the inverted flight position and remove the 46 rear-frame-to-front-frame flange bolts and nuts.

b. Remove the outer insulation blanket from the rear frame and remove the six pins from the rear-frame-to-scroll turnbuckles.

c. Remove 46 nuts from the "hot side" of the rear frame flange.

d. Assemble the T-bar (Par. 3.9) and slings (Par. 3.9) to the rear frame and lift the frame from the assembly.

CAUTION

As the rear frame is raised, guide it carefully over the rotor to avoid damage to the bucket tip shrouds.

6.3 REMOVE ROTOR FROM FRONT FRAME

a. Remove the magnetic speed pick-up sensor.

b. Remove the roller bearing housing by removing the 12 flange bolts and nuts. Using three 1/4 - 28 jacking screws, work the housing from the frame and slide the roller bearing from the shaft.

c. Bend the tab from the retaining nut and remove the retaining nut using the spanner wrench (Par. 3.7).

d. Remove the top half of the thrust bearing inner race using the puller per Par. 3.2.

e. Attach the rotor lift fixture (Par. 3.10) and lift the rotor vertically out of the front frame.

f. Install the rotor in the rotor build-up fixture (Par. 3.10), or place it on the rotor support stand (Par. 3.10).

6.4 REMOVE SCROLL FROM FRONT FRAME

a. Remove the center mount pin and snap ring. The pin is threaded to accommodate a #10-32 puller screw.

b. Remove the pins from the two end mounts.

c. Remove the air seals and supports.

d. Remove the inner scroll seal segments.

e. Lift the scroll from the front frame

6.5 DISASSEMBLE FRONT FRAME

6.6 Remove Circular Vane

a. Remove two bolts from each end of the circular vane. Working from the inside of the bulletnose, remove the top bolt from each end of the two straight vanes. Remove the bolts from the 45^{o} mounts. Remove all four quadrants.

6.7 Remove Thrust Bearing Outer Race

a. Remove 12 bolts and nuts and lift the thrust bearing retainer from the frame. Lift the balls and cage from the outer race.

b. Using the thrust bearing race puller (Par. 3.3), remove the outer race.

c. Remove the top grease shield.

6.8 Remove the Roller Bearing

a. Remove the eight bolts from the roller bearing retainer.

b. Using the roller bearing race puller (Par. 3.5), remove the roller bearing outer race.

c. Remove both bottom grease shields and the Teflon gasket.

6.9 Remove the Insulation Blanket

a. Remove all bolts and nuts from the blanket. Remove the remaining honeycomb seals and seal supports.

b. Break the Nichrome strips that hold the blanket to the flange.

c. Lift the blanket from the front frame flange.

6.10 Remove Scroll End Clevises

a. Remove four bolts and nuts from each clevis and remove the clevis.

6.11 Remove Speed Pick-up Bushing

a. Remove the retainer nut from the speed pick-up bushing and remove the bushing by sliding it toward the center of the hub.

6.12 DISASSEMBLE ROTOR

6.13 Remove Carrier Segments

a. Remove the carrier bolts and slide the covers from between each blade.

b. Remove the carrier pin retainer from each carrier pin.

c. Use the following procedure to remove each of the 18 carrier segments:

1. Use the pin knock-out tool (Par. 3.11) to remove the two pins from the carrier segment.

NOTE

The carrier pins must be removed by driving them from the center of the carrier toward the end.

2. Remove the carrier segment
3. Remove the seal segment.

d. Remove the top and bottom torque band.

6.14 Disassemble Blades

a. Position the rotor in the inverted flight position and remove each of the 36 blade platforms by removing one bolt from each side of each platform.

b. Remove the aft retainer ring.

c. Slide each of the 36 blades out of the disc.

6.15 Disassemble Bearings

a. Bend the tabs on the roller bearing inner race and, using the roller bearing race puller (Par. 3.4), remove the inner race and shims.

b. Remove the bottom half on the thrust bearing race using the thrust bearing race puller (Par. 3.2).

6.16 DISASSEMBLE REAR FRAME

6.17 Remove Exit Louvers

a. Remove each louver by removing the two bolts from the outer end support and sliding the support off the end of the louver.

b. Slide each louver away from the center strut and gently work the louver arm from the spline drive.

c. Slide all splines from the strut.

6.18 Remove Push Rods

a. Remove the pin and snap ring from the 6 o'clock end of the long push rod.

b. Slide both push rods out of the strut.

c. Remove the pin and cotter pin from the push rod and remove the lever arms.

6.19 Remove Insulation Blanket

a. Remove the bolts which hold the flat blanket and remove the blanket.

b. Remove the Nichrome strips which hold the blanket to the flange.

c. Remove the radial bolts and nuts from the curved blanket and remove the blanket.

6.20 Remove Air Seals

a. Remove the bolts from the air seals and remove the seals.

6.21 DISASSEMBLE DIVERTER VALVE

6.22 Actuation Removal

a. Remove the cotter pin from the end actuator pin and remove the actuator pin from the support bracket.

b. Remove the bolts from the forward and aft torque arms located on the actuator-linkage side of the valve body.

c. Slide the torque arms and actuator linkage (as a unit) from the valve body.

6.23 Door Removal

a. Remove one bolt from each of the shafts located on the side of the valve body opposite the actuator linkage. Slide the doors from the valve body.

6.24 Insulation Blanket Removal

a. Cut the lockwire lacing which holds the blanket and remove the blanket from the valve body.

6.25 Diffuser Removal

a. Remove the bolt and nut from each of the four diffuser support mounts and remove the mounts by sliding them radially out of the valve body. Remove the diffuser by sliding it toward the forward end of the valve body.

SECTION 7.

INSPECTION, REPAIR AND REPLACEMENT

7.1 GENERAL

a. This section provides initial field maintenance guidelines for the X353-5B Lift Fan and Diverter Valve. These guidelines are based on development test experience and design analysis. The large, thin sheet metal used in construction of the fan is subject to nominal contour distortions; however, the distortions normally will not adversely affect the performance or life of the parts. In the following tabulation (Table 7.2, Maximum Serviceable Limits and Repair Limits), an asterisk (*) is placed at items which represent conditions which should be expected to exist after normal operation. For example, the staggered sawcuts in the rear frame flanges often break through or distort. These would be cut through at manufacture except that machining of the large flange is made easier by retaining the flange as an integral piece. Such a condition after operation is to be expected and is normal. Questions concerning any hardware condition not adequately described should be referred directly to the General Electric Company.

7.2 CLEANING AND INSPECTION

a. The following paragraphs (7.3, 7.4, 7.5, 7.6, 7.7, and 7.8) and Table 7.1 outline recommended general procedures for cleaning and inspecting fan hardware.

7.3 Cleaning of Bearings

NOTE

Clean ball and roller bearings in a separate area (removed from the general cleaning area). Keep this area free of dust and lint and well lighted.

a. To clean used bearings:

(1) Loosen oil and grease by soaking the bearings in an agitated solution, Specification MIL-L-6082. Maintain this solution at a temperature of 106°C to 122°C (225°F to 250°F). As an alternate, Federal Specification P-S-661 may be used, provided it is used at room temperature only. If bearings are coated with carbon, a compound carbon remover, such as Turco-Fuzee (or equivalent), may be added to the solution to increase the effectiveness of the cleaning operation. Soaking time varies from 30 minutes to several hours, depending on the type and amount of contaminant to be removed.

(2) After cleaning, rinse the bearings in a clean solution, Federal Specification P-S-661. To this solution, add 3 per cent to 5 per cent (by volume) of anti-corrosion oil, Specification MIL-L-7870 (or MIL-L-6085). This oil prevents the formation of corrosion when bearings are dry.

(3) To dry bearings, flow filtered, heated, clean, dry air (under pressure) over all of the parts.

NOTE

> Do not handle cleaned bearings with bare hands. Wear clean, lint-free gloves (such as surgical gloves) or gloves made of neoprene and nylon. Keep all handling to a minimum to reduce the possibility of damage or contamination. Do not remove bearings from the cleaning and inspection area in a dry condition.

b. To clean new bearings: Open anti-friction bearings are normally preserved with oil or a preservative compound. Before installation of these bearings, remove the preservative compound by washing the bearings in a bath of a continuously filtered solvent, Specification P-S-661, or warm lubricating oil, Specification MIL-L-6082. Bearings preserved in oil require no depreservation prior to use.

7.4 Fluorescent-Penetrant Method of Inspection (Zyglo)

7.5 General

Inspection by the fluorescent-penetrant method, Specification MIL-I-6866, is a nondestructive means of testing nonferrous parts for cracks and defects that have openings to the surface. A highly fluorescent, water-emulsifying, low-viscosity oil is applied to a completely clean surface, and allowed to penetrant any flaws. The surface oil is then removed. The residual oil which has penetrated the flaws glows when exposed to ultraviolet light, thus revealing the extent of the defects.

7.6 Cleaning Prior to Application of Fluorescent-Penetrant

Be sure surfaces to be inspected are free of foreign materials (such as heavy oil, grease, rust, or scale) which would either prevent penetration of the oil, or indicate false flaws by absorbing the penetrant. Polishing causes false inspections because displaced surface metal can cover defects and thereby close the surface openings of deeper flaws. Remove heavy oils by degreasing, and remove dirt and scale by the applicable cleaning method.

7.7 Application of Fluorescent-Penetrant Oil

Apply the fluorescent-penetrant oil by immersing the part, or by flowing the oil over it. Allow approximately one hour for the oil to penetrate into the surface openings. Immerse in the emulsifier and drain 3 to 5 minutes. Apply a warm-water spray to remove excess oil from the part, so that only the oil which has penetrated deeply into the flaws remains. Dry the part in a soft flow of warm, dry air.

7.8 Application of Developer

After all excess fluorescent oil has been removed, cover the part with developing powder. The developer draws the oil trapped in the defects to the surface. When the part is examined in a darkened booth under ultraviolet (black) light, the oil that is developed from the defects is readily visible. The nature and extent of the flaws can be determined by the extent of the development around the defects.

WARNING

> Developing powder is not harmful to inhale, but can be annoying in a heavy concentration. Dermatitis is apt to result if the penetrating oil remains on the skin for several days. To avoid this, use brackets to hold the parts and neoprene gloves when necessary. The presence of penetrating oil on the skin can be detected under black light.

7.9 BLADE TANG AND BLADE/DISC DOVETAIL COATING

a. Metal Spray Coating on Rotor Blade Dovetails

The lift fan blade root dovetail attachment has been spray coated to delay base metal fretting. This coating is copper nickel indium applied per GE Specification P50T308A. The coating covers the entire dovetail except the bottom, and the fore and aft ends. The coating application is 0.002" to 0.004" thick and extends radially 0.675" from the bottom of the dovetail. Blades must be examined during each teardown for general coating integrity. No spalling or complete loss of coating is permitted. Blades deviating from this specification should be replaced and the damaged blade returned to General Electric, Evendale, for re-coating.

b. Graphite - Resin Coating, Blade Dovetail, Blade Tang, and Disc Dovetail

Elements noted above have been treated with a phenolic resin/graphite coating to inhibit base metal fretting or galling. Coating to be applied to GE Specification P50T3. Coating coverage delineated by blade drawing.

TABLE 7.1

CLEANING AND INSPECTION METHODS

Part	Cleaning Procedure	Inspection Method
LIFT FAN		
Front Frame	Clean by hand using petroleum-base solvent	Spot zyglo weld areas
Circular Vane	Clean by hand using petroleum-base solvent	Spot zyglo weld areas
Honeycomb Seals and Supports	Vapor hone	Zyglo
Bearings	Refer to Par. 7.3	Magnaflux
Rear Frame	Clean by hand using petroleum-base solvent	Spot zyglo weld areas
Exit Louvers		
(Inconel)	Vapor hone	Zyglo
(Aluminum	Clean by hand using petroleum-base solvent	Spot Zyglo
Scroll	Clean by hand using petroleum-base solvent	Spot zyglo weld and braze area
Disc and Shaft	Clean by hand using petroleum-base solvent (NOTE: mask vent holes)	Magnaflux dovetails and shaft
Blade Platforms Retainers and Covers	Degrease - Maximum Temperature 250°F	Zyglo
Blades	Vapor hone (NOTE: mask off root and tang)	Magnaflux
Carriers	Vapor hone	Zyglo
Torque Band	Degrease	Zyglo
Seal Segments	Vapor hone	Zyglo
Pins	Degrease	Zyglo
Scroll Mounts, Seals, and Louver Support Hardware	Degrease	Zyglo
DIVERTER VALVE		
Valve Body	Clean by hand & degrease	Zyglo weld areas
Doors	Degrease	Zyglo weld areas
Actuation (except actuator)	Degrease	Zyglo

TABLE 7.2
MAXIMUM SERVICEABLE AND REPAIR LIMITS

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Lift Fan Front Frame</u>			
1. Cracks			
A. All sheet metal except strut skins and hub	None allowable	No limit	a) Stop drill 0.060" to remove end of cracks b) Weld using 321SS filler material - gas back-up required
B. Strut skins	None Allowable	1/4 inch located 1 inch away from strut caps	Same as 1-a above except must be reviewed by G.E.
C. Hub can skin	None allowable	1/4 inch	Same as 1-b above
D. Weld joints except transverse weld in strut caps, mounts, and hub - see 1-E.	None allowable	a) To be reviewed by G.E. b) Zero cracks on strut caps and hub plates.	a) Grind to remove crack and zyglo b) Weld using 321SS filler material - Use gas back-up and keep adjacent parts cool

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
E. Strut caps, hub plates, mounting pads, and scroll mounts	None allowable	[illegible] reviewed by G.E.	To be reviewed by G.E.
F. Braze joints, strut skin to strut caps - minor strut	None allowable	Same as 1-E	Same as 1-E
G. Braze joints, strut skin to to strut stiffeners	20% of joint	No limit	Use 1/8 inch diameter brazier head explosive rivets - Monel or equivalent 1/2 inch spacing

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
2. Shank Nuts			
A. Loss of locking action	Not allowed	Not repairable	Replace
B. Looseness	No limit if assembly can be made	Not repairable	Replace
C. Dents and Bulges	Small sharp radii not allowed	Reviewed by G.E.	Reviewed by G.E.
3. Bulletnose Rivets			
A. Loose or missing	One loose each gusset	Not repairable	Replace

TABLE 7.2 - Continued

INSPECT	MAX, SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Circular Vane</u>			
1. Cracks			
A. Leading and trailing edge	None allowed	No limit	a) Grind out crack b) Clean surface using wire brush and Acetone c) Weld per dwg. 4012001-405 using gas backup
B. Skins	One inch - all cracks to be stop-drilled (repair when first noted)	No limit	Stop-drill 0.060" each end of crack - remove sharp edge from hole
C. Mounting Pads	None allowed	Not repairable	Replace
2. Bearings			
A. End play and clearance	0.010" axial 0.005" Radial	Not repairable	Replace
3. Fretting			
A. End mounts	0.001" per side	Reviewed by G.E.	Reviewed by G.E.
B. Mount bolts	0.001" dia. reduction		

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Bearings</u>			
1. End play and radial clearance	Dwg. 4012001-222 or -223 requirements	Not repairable	Replace
2. Wear - Visual including surface condition	Maintenance judgement	Not repairable	Replace
3. Rust	None allowed	No limit	a) Remove using crocus cloth and oil b) Coat with MIL-7808 for storage
<u>Grease Seals</u>			
1. Lip edge tears, grooves and resilience	None allowed (maintenance judgement)	Not repairable	Replace

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Forward Air Seals</u>			
1. Braze			
A. Honeycomb to sheet cracks	20% of area located within 0.1" border of outer edge	Not repairable	Replace
2. Buckles	Maintenance judgement	No limit	Straighten, check bolt torque

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Lift Fan Rear Frame</u>			
1. Cracks or Cuts			
A. All sheet metal parts except vanes, sawcut areas and louver brackets	1 inch	No limit	a) One inch or less-stop drill with 0.125" holes b) Over one inch in length-weld with Hastelloy W filler mat'l.
B. Vanes	1/4 inch	1 inch	a) 1/4" or less - stop drill with 0.060" holes b) 1" or less - add 0.020" stk. thk. patch with 1/4" overlap and braze with gold-nickel filler material
C. Louver brackets	1/4 inch	No limit	Weld with Hastelloy W filler material
D. Extension of sawcuts			
1. Outer skin & flanges	No limit	No limit	Nichrome strip if necessary to reduce hot gas leakage
2. Circular box	1/2 inch	No limit	a) 1/2" or less - stop drill with 0.125" holes b) Over 1" in length - weld with Hastelloy W filler material
E. All weld joints except above	1/2 inch	No limit	a) 1" or less - stop drill with 0.125" holes b) Over 1" in length - weld with Hastelloy W filler material

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
F. All braze joints except ends of vane	1/2 inch	No limit	Braze with gold-nickel filler material
G. Braze joints at ends of vane	1/4 inch	No limit	Braze with gold-nickel filler material
*2. Nicks and scratches	No limit provided mat'l thickness not reduced greater than 1/10 mat'l thickness	No limit	a) Less than 1/10 mat'l thickness - blend affected area b) Over 1/10 mat'l thickness - repair same as a crack
*3. A. Dents & bulges in sheet metal other than vanes	No limit provided operation or assembly is not effected	Same as Maximum Serviceable Limits	Rework to approximate original contour
B. Dents & bulges in vanes	1/8" from original contour	1/4" from original contour	Rework to approximate original contour or fill with gold-nickel braze as required
4. Loose shank nuts	No limit if assembly of louvers can be made	No limit	Replace
<u>Exit Louvers</u>			
<u>Inconel X Louvers</u>			
1. Cracks			
A. All sheet metal areas	1/2 inch	No limit	Weld with Hastelloy W filler material
B. Actuation attachment structure in sheet end of louver	1/8 inch material width	No limit	Weld with Hastelloy W filler material

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
2. Loose shank nuts	No limit provided assembly is possible	No limit	Replace
<u>Aluminum Louvers</u>			
1. Cracks			
A. All sheet metal areas except spot welds	1/4 inch	1/2 inch	Stop drill crack ends using 0.06" Diameter holes.
B. Actuation attachment structure in strut end of louver	1/8 inch of material width	No limit	Weld with Hastelloy W filler material
C. Outboard attachment end of louver	1/4 inch	No limit	Clean and repair weld using AMS 4190A filler material
2. Pulled spot welds	a) 0 at attachment end	a) 2 any row, 1st 5 spots	Repair with POP rivet MD419BS
	b) 3 any row louver middle	b) No limit	"
	c) 2 any row outboard end	c) No limit	"
3. Loose shank nuts	No limit provided assembly is possible	No limit	Replace
<u>Insulation Blankets</u>			
1. Cracks, gouges, nicks, and scratches	No limit provided operation or assembly is not affected	No limit	If exceeds max. service limit - weld with Hastelloy W filler mat'l
* 2. Buckles and bulges	Same as item 1	No limit	Return to approximate original contour or split, flatten and weld (Hastelloy W)

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
Lift Fan Louver Actuation System			
1. Cracks	No cracks allowed	a) Except push rods, no cracks allowed b) Push rods 1/4 inch	a) Replace b) 1) Fabricated Inco. X Rods: Grind out crack and repair weld using Hastelloy W filler material 2) Solid 17-4PH Rods: Grind out crack and repair using AMS 5825 filler material
2. Wear and bent parts	No limit provided operation is not impaired	Same as Maximum Serviceable Limit	Replace

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>LIFT FAN SCROLL</u>			
1. Cracks			
A) Skins & Hat Sections	3/8 inch	No Limit	a) 3/8" or less 1) Surface crack less than 1/5 material thickness - blend affected area. 2) More than 1/5 material thickness Stop drill using .06 dia. holes if gas leakage can be tolerated. b) Over 3/8" or if gas leakage can not be tolerated - bench out crack and repair weld using Hastelloy X filler material. Inert gas back-up must be used.
B) Nozzle Partitions			
1) Sections I & II			
a) Trailing Edge	1/8 inch	No Limit	a) 1/8" or less - Bench out crack and blend to form smooth profile going no deeper than .150 from edge of partition. b) Over 1/8" - Bench out crack and repair weld using Hastelloy X

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
			filler material. Inert gas back-up must be used. Blend to match airfoil contour of partition.
b) All Other Areas	1/4 inch	No Limit	a) 1/4" or less - Stop drill with .060 dia. holes. b) 1/4" or more - Bench out crack, repair weld using Hastelloy X filler material. Inert gas back-up must be used. Blend to match airfoil contour or partition.
2) Sections III, IV & V			
a) Trailing Edge	1/4 inch	No Limit	a) 1/4" or less - Stop drill using a .06 dia. holes. Edge of hole must be less than .350" from edge of partition. b) 1/4" or more - Bench out crack and repair weld using Hastelloy X filler material. Inert gas back-up must be used. Blend to match airfoil of partition.
b) All Other Areas	1/4 inch	No Limit	a) 1/4" or less - Stop drill using .06 dia. holes.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
			b) 1/4" or more - Bench out crack and repair weld using Hastelloy X filler material. Inert gas back-up must be used. Blend to match airfoil contour of partition.
C) Struts	1/4 inch	No Limit	a) 1/4" or less - Stop drill with .060 dia. holes if gas leakage can be tolerated. b) 1/4" or more, or if gas leakage can not be tolerated. Bench out crack and repair weld using Hastelloy X filler material. Inert gas back-up must be used. Do not bench weld after repair.
D) Splitter Vanes			
a) Vanes	.05 inch	No Limit	a) Bench out crack - Repair weld using AMS 5796 filler material and gas back-up. Blend to match airfoil contour of vane.
b) Shafts	.05 inch	No Limit	a) If crack is in slot - Bench out crack and repair weld using Hastelloy X filler material. Dress repair only sufficiently to allow assembly of vane.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
			b) If crack is more than 1/4" away from slot: 1) less than .05 - Bench out crack and blend. 2) Over .05 - bench out crack and repair weld using Hastelloy X filler material.
E) Welds	3/8 inch	No Limit	a) 3/8" or less - Stop drill with .06 dia. hole if gas leakage can be tolerated. b) Over 3/8" or if leakage can not be tolerated - Bench out crack and repair weld using Hastelloy X filler material. Gas back-up is required. Do not bench weld after repair.
F) Brazed Joints	3/8 inch	No Limit	a) Clean joint and T.I.G. braze with AMS 4777 cast rod material.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
* 2. Nicks and Scratches	No limit provided. Material thickness not reduced greater than 1/5 material thickness.	No Limit	a) Less than 1/5 material thickness - Blend affected areas. b) Over 1/5 material thickness - Repair same as crack.
* 3. Dents and Bulges			
a) Skins and Hats	No limit provided operation or assembly is not affected.	Same as Maximum Serviceable Limits.	a) Rework to original contour.
b) Struts and Partitions	1/8" from original contour.	No Limit	a) No action if less than 1/8" and no sharp discontinuities exist. b) Over 1/8" - Rework to original contour.
4. Loose Shank Nuts	No limit if assembly of mating hardware can be made.	No Limit	a) Replace

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
LIFT FAN ROTOR			
Disc (except D/T Slots)			
1. Cracks	Except D/T slots - Not permitted.	Not Repairable	Replace
2. Dents, Nicks and Scratches	None Allowed	Any number 3 - 5 mils in depth.	Blend and polish - no sharp bottoms.
3. Paint Spalled off or Missing	Not Permitted	Repair to Spec.	Repaint to Spec.
4. Threads in Pickup Lugs for Damage	Any amount which permits three bolts assembled to at least 10 diameter.	No Go - Gage Limit	Re-tap - de-burr
5. Bolt Study for Looseness and Mis-alignment	Looseness and misalignment permitted as long as retainer ring and nut assembly leaves at least two threads beyond nut.	Re-alignment to provide thread symmetry on both sides of disc rim.	a) Loose - Replace b) Misaligned - jack into position with locknut.
6. Vent Holes for Foreign Material	None Permitted	Holes to be clear.	Clean hole with probe.
7. Bolt Studs for Thread Damage	No nicks at transition thread to shank - Threads do not accept no go.	De-burring of threads limited by acceptance of no go gage.	De-burr - If accepts no go - Replace.
Shaft			
1. Cracks	None Permitted	Not Repairable	Replace disc-shaft assembly.
2. Paint Milling or Spalled	Not Permitted	Repaint to Spec.	Repaint to Spec.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
3. Marks on Bearing Race (Circumferential)	.003"-.005" Depth no more than one mark per inch of shaft length.	.003"-.005" Depth one mark/linear inch of shaft length.	Blend and polish. No flat spots on shaft.
4. Bearing Retainer Thread Damage	No high metal. Not accept no go gage.	No go gage.	Replace assembly.
Disc Rim Dovetail Slots			
1. Cracks	None Permitted	Not Repairable	Replace
2. Dents, Nicks and Scratches on profile	None Allowed	Any number .003"-.005" depth.	Polish - Edge must be radius.
3. Dents, Nicks and Scratches D/T Pressure Face	None Allowed	Not Repairable	Refer to G.E.
4. Bottom of D/T Slot Nicks, Scratches	None Allowed	Any number .003"-.005" depth.	Blend, polish - No high metal.
5. Aquadag Loose, Missing, Spalled	Not Permitted	Any part of pressure face exposed.	Recoat surface.
6. Fretting	Not Permitted	Not Repairable	Refer to G.E.
Retainer Rings			
1. Cracks (Parent Mat'l)	None Allowed	Not Repairable	Replace
2. Bent Tabs	.050" Displacement at tab tip - No kinks or sharp bends.	Not Repairable	Replace Ring
3. Lock Nut fo [illegible]ocking Action	Must meet Spec. (torque) not accept no go	de-burr - not accept no go - meet torque Spec.	Remove from ring replace.
4. Hole Damage Disc Rim Bolt	No high metal No sharp edges	10% increase in hole dia.	Ream new hole, de-burr and break edges.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
5. Cracks in Lock Nut Attachment Weld	None Permitted	Not Repairable	Remove nut, clean parent material, weld new nut
* 6. Nicks, Scratches	Any number .003" depth	Any number .003" depth	Blend and polish
7. Dents in Flanges	Not Permitted	Not Repairable	Refer to G.E.
Rim Locknuts (Disc)			
1. Cracks	None Permitted	Not Repairable	Replace
2. Locking Action	No go gage, torque Spec.	No go gage, torque Spec.	Replace
Platforms			
1. Cracks (Weld and Parent Material)	None Permitted	Not Repairable	Replace
* 2. Nicks, Scratches	Any amount up to .003" depth, 1/2" long	Any amount up to .003" depth, 1/2" long	Replace
* 3. Dents	Any amount up to .050" depth, no high metal, sharp corners	Any amount up to .050" depth	Replace
4. Loose Grommets	Any amount-circumferential. None permitted - axial.	Any amount (circumferential). No axial movement repair permitted.	Replace
Blades (Except Dovetail and Tip Tang)			
1. Airfoil Cracks	None Permitted	Not Repairable	Replace
* 2. Nicks, Scratches	Not Permitted	Any amount .003" depth up to 1" from tang and 2" airfoil shank.	Blend and polish, polish must be longitudinal.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
* 3. Cuts Leading Edge & Trailing Edge	None Permitted	Any number (1" from tang and 2" shank) .060" depth and 1 cut in each inch of blade length not in line LE & TE.	Blend and polish, break edges.
4. Cuts LE & TE 1" Tang 2" Shank	Not Permitted	Not Repairable	Refer to G.E.
5. Cuts Convex & Concave	None Permitted	Not Repairable	Refer to G.E.
* 6. Dents LE & TE	Any amount .100" depth, not sharp or kinked (1" Tang. 2" Shank) no more than 1/linear inch blade length, not in line LE&TE.	Any amount .100" depth, not sharp or kinked (1" Tang 2" Shank) 1/linear inch of blade length not in line LE & TE.	Break edges, remove high metal, replace.
<u>Blade Shank & Dovetail</u>			
1. Cracks	None Permitted	Not Repairable	Replace
2. Nicks, Scratches	None Permitted	Not Repairable	Refer to G.E.
3. Nicks, Scratches Dovetail Profile & Pressure Face	None permitted	Not Repairable	Refer to G.E.
4. Dovetail Coating Spalled or Missing	Not Permitted	Repair per Spec.	Repair per Spec.
5. Dovetail Fretting	Not Permitted	Not Repairable	Refer to G.E.
<u>Blade Tip Tang</u>			
1. Cracks	None Permitted	Not Repairable	Replace

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
2. Nicks & Scratches Face of Tang.	None Permitted	Not Repairable	Refer to G.E.
3. Aquadag	Surface 90% covered	Surface 90% covered	Recoat per Spec.
4. Fretting Face of Tang	None Permitted	.001" depth	Polish, refer to G.E.
5. Fretting Tang Hole	None Permitted	Polish Tang hole to max. pin dia. determined by carrier.	Polish tang hole to max. dia. determined by carrier.
6. Nicks, Scratches Edge of Tang Hole	None Permitted	.005" depth	Polish to remove radius edge of hole.
7. Deformation in Tang Hole	.003"-.005" at top of hole, no high metal sharp edges	.003"-.005" at top of hole	Polish to remove high metal, sharp edges, diameter limited by carrier, if at max. replace.
<u>Torque Band</u>			
1. Cracks	None Permitted	Not Repairable	Replace
2. Buckles	None Permitted	Not Repairable	Replace
* 3. Dents, Nicks, and Scratches	None Permitted	.001"-.003" depth, any amount	Polish, break sharp edges.
4. Hole Damage	None Permitted	+10% Hole diameter, non torque tab (only)	Ream hole, polish and break edges.
5. Missing Grommets	Not Permitted	None Permitted	Replace with new grommet
6. Copper Nickel Indium on Non-Torque Tab Missing or Spalled	70% of area covered	70% of area covered	Replace with new coating per Spec.
7. Fretting	.001" depth any location	.001" depth any location	Refer to G.E.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Covers</u>			
1. Cracks	None Permitted	Not Repairable	Replace
* 2. Nicks, Scratches	.001"-.003" depth, any location	.001"-.003" depth any location	Replace
* 3. Dents	.030"-.050" depth, any location	.030"-.050" depth, any location	Replace
4. Bent Tabs	.030" displacement at top of tab must be smooth, no kinks	Not Repairable	Replace
5. Lock Nuts loose or missing	Not Permitted	Fix or Replace	Loose - reweld Missing - replace
6. Lock Nuts locking action	No go on Spec. torque	Not Repairable	Replace
<u>Blade Carrier Pins</u>			
1. Cracks	Not Permitted	Not Repairable	Replace
2. Deformation	.001" bow	Not Repairable	Replace
3. Nicks, Scratches	No high metal, sharp edges	Drawing tolerance (contour)	Polish to remove high metal, sharp edges, check contour.
4. Hole damage	No burrs, sharp metal	No burrs, sharp metal	De-burr, remove high metal
<u>Blade Carrier Seal</u>			
1. Cracks	None Permitted	Not Repairable	Replace
* 2. Nicks, Scratches	None Permitted	Any amount up to .003" depth	Polish, brea[illegible] p edges.
* 3. Dents (Lip)	Up to .050" smooth, not kinked, 1/linear inch	Up to .050", smooth, not kinked, 1/linear inch	Break sharp edges, remove high metal.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
* 4. Rubs	Up to .030" depth, no high metal, sharp edges	Up to .050" depth, no high metal, sharp edges	Blend, polish - radius edges.
<u>Turbine Sector</u>			
1. Cracks (Carrier)	None Permitted	Not Repairable	Replace
* 2. Nicks, Scratches	Up to .003" depth	Up to .003" depth	Polish, break sharp edges
3. Tang Slot Nicks, Scratches	Up to .001" depth	Up to .001" depth	Polish
4. Cross Beam Hole Nicks, Scratches at Hole Radius	Not Permitted	Up to .003" depth	Polish - edge must be radius
5. Cross Beam Hole Nicks, Scratches	Not Permitted	Up to .001" depth	Polish hole, max. dia. and determined by blade pin diameter.
6. Cross Beam Ret. Pin Hole for Burrs, Foreign Metal	None Permitted	No high metal, foreign metal	De-burr, clean hole, radius outer edge.
7. Cross Beam Hole for Deformation	Up to .003" depth, no high metal, sharp edges	.003" depth	Polish hole, max. dia. determined by blade pin diameter.
8. Bucket-Carrier Braze for Cracks	None Permitted	Not Repairable	Replace
* 9. Buckets for Dents	All except 1" from carrier, dents up to .050" permitted at LE, TE does not break parent material	Not Repairable	Refer to G.E.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
10. Buckets for Cuts, Nicks	Within 2" of carrier not permitted	Not Repairable	Replace
	Above 2" from carrier - up to .060" wide, break p/m	Not Repairable	Refer to G.E.
11. Buckets - Shroud Braze for Cracks	Total accumulated cracks up to 1/2" in length	Total accumulated cracks up to 3/4" in length. No single crack greater than 1/2" in length.	Torch repair per Spec. Refer to G.E.
12. Bucket-Shroud Cracks in Parent Material TE Lip	Lip may be completely cracked	Remove lip	Break sharp edges
Rest of Shroud	Not Permitted	Not Repairable	Refer to G.E.
13. Missing Shrouds	Up to 1/2 shroud may be missing from TE. No two adjacent buckets.	Not Repairable	Refer to G.E.
14. Shroud Lip Rubs	Any amount up to .030" depth	Any amount up to .100" depth	Blend, polish, break edges.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
Diverter Valve			
1. Cracks A) Skins & Hat Sections	3/8 inch	No limit	a) 3/8" or less 1. Surface crack less than 1/5 mat'l thkns blend effected area. 2. More than 1/5 mat'l thkns - stop drill with .06 dia. hole, if hot gas leakage can be tolerated. b) Over 3/8 or if gas leakage cannot be tol-erated - bench out crack and repair weld using Hastelloy X filler mat'l and inert gas back-up. Do not bench weld after repair.
B) Doors 1) Main structure	3/8 inch	No limit	a) 3/8" or less-stop drill with .06 dia. holes. b) Over 3/8 - bench out crack and repair weld using Hastelloy X filler material and gas back-up.
2) Heat shields	1/4 inch	No limit	a) 1/4" or less - stop drill with .06 dia. holes. b) 1/4" or more - repair weld using Hastelloy X filler material.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
3) Center beam to stiffening rib welds	No cracks allowed - Repair when discovered	No limit	a) Repair using Hastelloy X filler and inert gas back-up. X-Ray repair. No cracks or lack of penetration allowed.
C) Linkage 1) Bellcranks	3/16 inch	No limit	a) 3/16 or less on edge of parts-bench out crack and blend to form smooth profile. b) 3/16 or less and away from.edges-stop drill using .06 dia. holes. c) Over 3/16 - bench out crack, remove malcomizing within 1/2" of crack and repair weld using AMS 5786 filler material.
2) Stops	1/4 inch	No limit	a) 1/4 inch or less - bench out crack and blend effected area. b) Over 1/4 inch - bench out crack and repair weld using AMS 5680 filler material.
3) Mounting Bracket	1/4 inch	No limit	a) 1/4" or less 1) Edge crack - bench out crack and blend to form smooth profile. 2) Remote from edge stop drill using .06 dia. holes.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
			b) Over 1/4" - bench out crack and either (1) stop drill using .06 dia. holes or (2) torch or furnace heat to 500°-600°F and repair weld using AMS 5776 filler material.
D) Welds	3/8 inch	No limit	a) 3/8" or less - stop drill with .06 dia. holes if gas leakage can be tolerated.
			b) Over 3/8 or if gas leakage cannot be tolerated - bench out crack and repair weld using Hastelloy X filler material and inert gas back-up.
2. Nicks and Scratches	No limit provided material thickness not reduced greater than 1/5 mat'l thickness	No limit	a) Less than 1/5 mat'l thickness - blend effected area.
			b) Over 1/5 mat'l thickness - repair same as crack.
3. Dents and Bulges	No limit provided operation or assembly is not effected	Same as Max. Serviceable Limits	Rework to approximately original contour.

7.10 PERIODIC INSPECTION REQUIREMENTS

1. Pre-Flight:

   a) Check rotor for freedom of movement.

2. Post Flight:

   a) Check rotor for freedom of movement.

   b) Check honeycomb seals for deep or heavy rubs.

   c) Check blade for nicks and dents.

   d) Check bucket airfoils for foreign object damage.

   e) Check rear frame for excessive cracks at sawcuts.

   f) Check circular vanes and rotor platform for cracks and foreign object damage.

3. 5 Hour (Recommended):

   a) Remove diverter valve - tailpipe bellows per removal instruction.

   b) Visually check valve doors and body for cracks.

   c) Repair all cracks per repair limits.

4. 25 Hour (Recommended):

   a) Remove diverter valves per disassembly instruction.

   b) Remove diverter valve door per instruction.

   c) Disassemble doors and inspect for cracks paying special attention to centerbeam to rib welds.

   d) Repair all cracks per repair limits.

5. 50 Hour to 100 Hour (Recommended):

   a) Remove rear frame and rotor per disassembly instruction.

   b) Visually check and repair per table of repair limits.

   c) Repack bearing.

6. Preservation:

   a) No preservation requirements have been established.

   b) Based on lift fan experience and grease packed bearings have a life of at least 12 months before repacking is required.

7.11 LIFT FAN SERIAL NUMBERS

Sub assemblies and lift fan assemblies will be assigned serial numbers at initial buildup and this number will be vibro-etched to the following assemblies in the location as noted below.

Left Fan S/N - 12 o'clock on major strut sloped end cap

Right Fan S/N - 6 o'clock on major strut sloped end cap

Front Frame S/N - on top on hub at outboard strut position

Rear Frame S/N - 12 o'clock just below flange

Rotor S/N - on Forward side of disc at #1 blade position

Scroll S/N - on Horizontal inlet Marmon flange, top side

Diverter Valve - On pad forward of unibal on the actuator side

SECTION 8.

TESTING AFTER OVERHAUL OR MAINTENANCE

8.1 GENERAL

Refer to Section II-8 for instructions for testing X353-5B lift fans and diverter valves after overhaul or maintenance in preparation for installation in the XV-5A aircraft.

SECTION 9.

OPERATION OF X353-5B PROPULSION SYSTEM

9.1 GENERAL

a. Operating limits of the X353-5B propulsion system are included in Section II-8 of this manual for reference. Detailed operating limits including flight envelopes, flight starting, jet wake diagrams, and system requirements are included in the following publications:

1. J85-GE-5 Model Specification
2. X353-5B Propulsion System Specification No. 112

b. Ground procedures are provided in both the J85-GE-5 Overhaul and Maintenance Manuals and Section II-8 of this manual. In-flight procedures for the J85-GE-5 turbojet engine should be obtained directly from:

The General Electric Company
Small Aircraft Engine Department
Turbotown, Massachusetts

c. For information on all other procedures related to hover or transition flight, such as control malfunction etc., refer to the XV-5A Aircraft Operating Instructions.

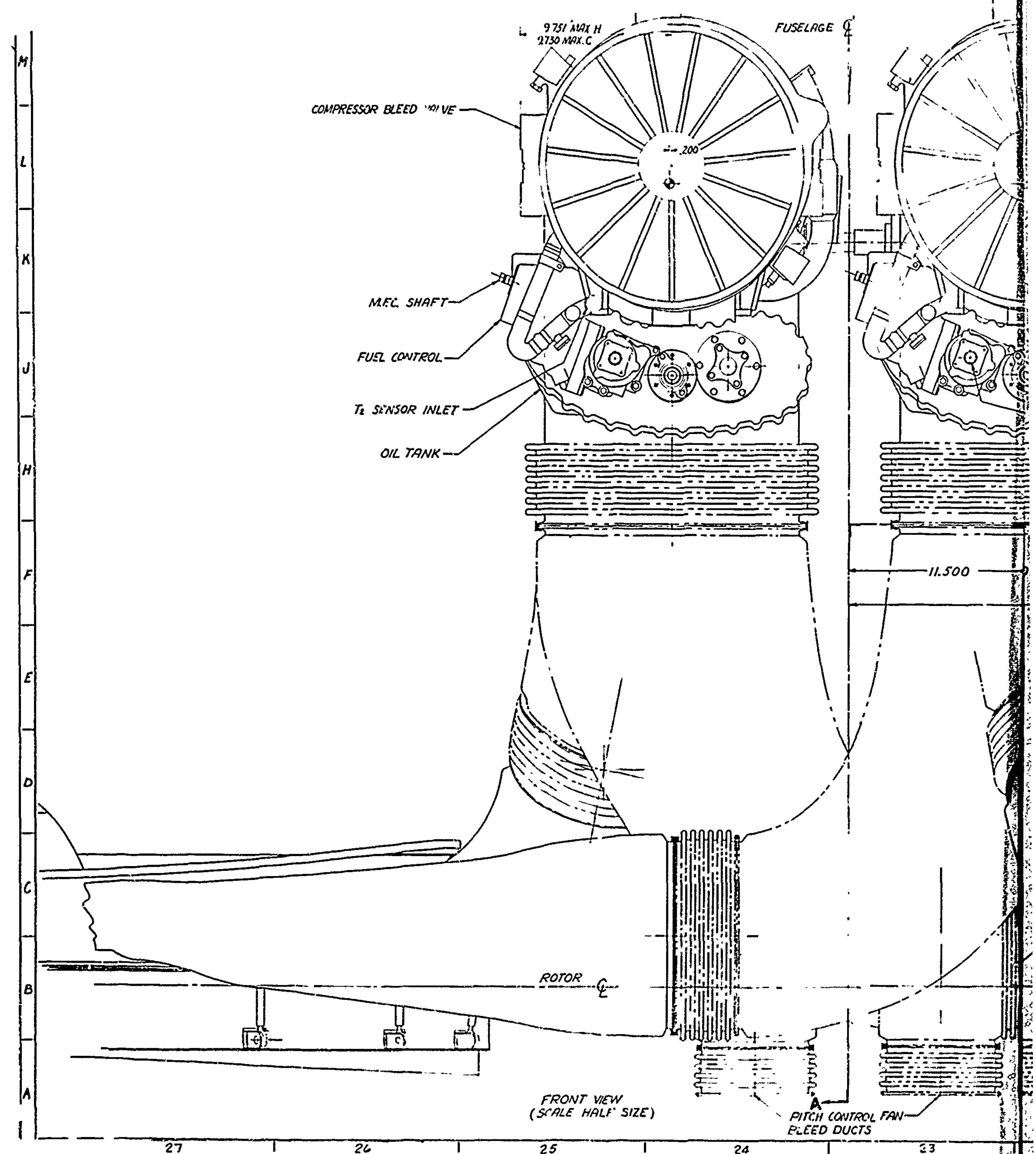
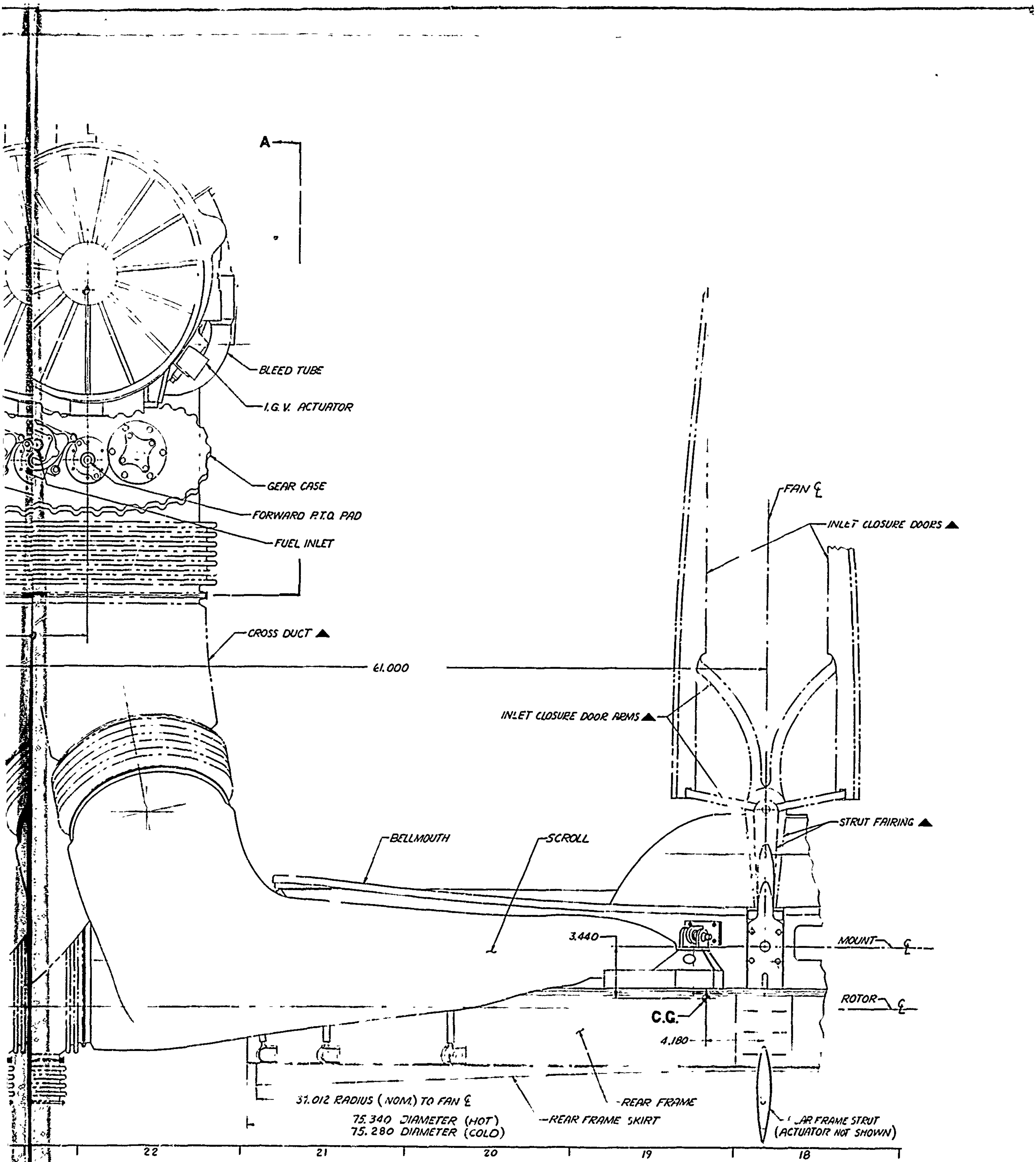


FIGURE 9.1 X353-5B (4012000



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B

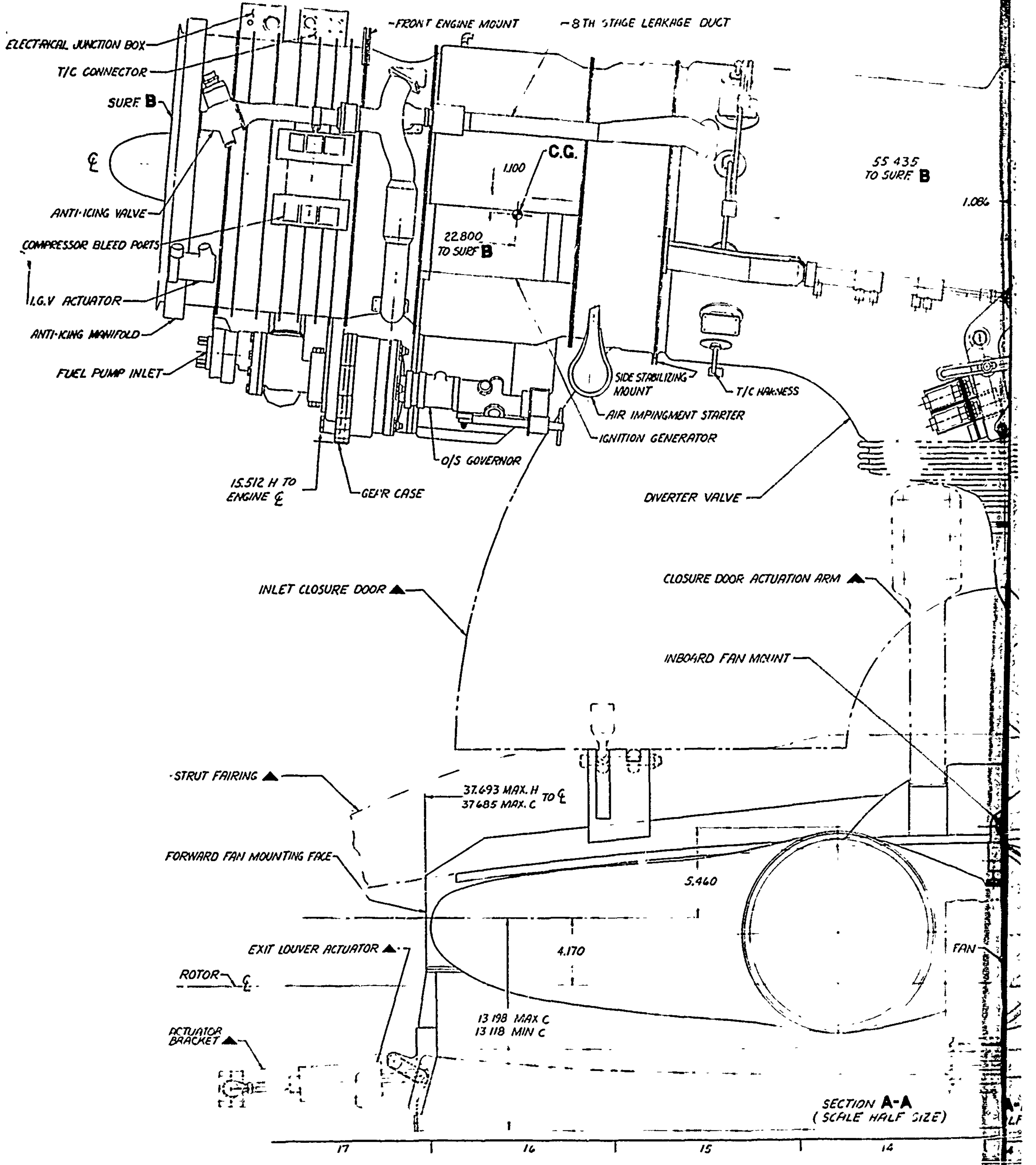

FIGURE 9.1 X353-5B SYST
(4012001-910)

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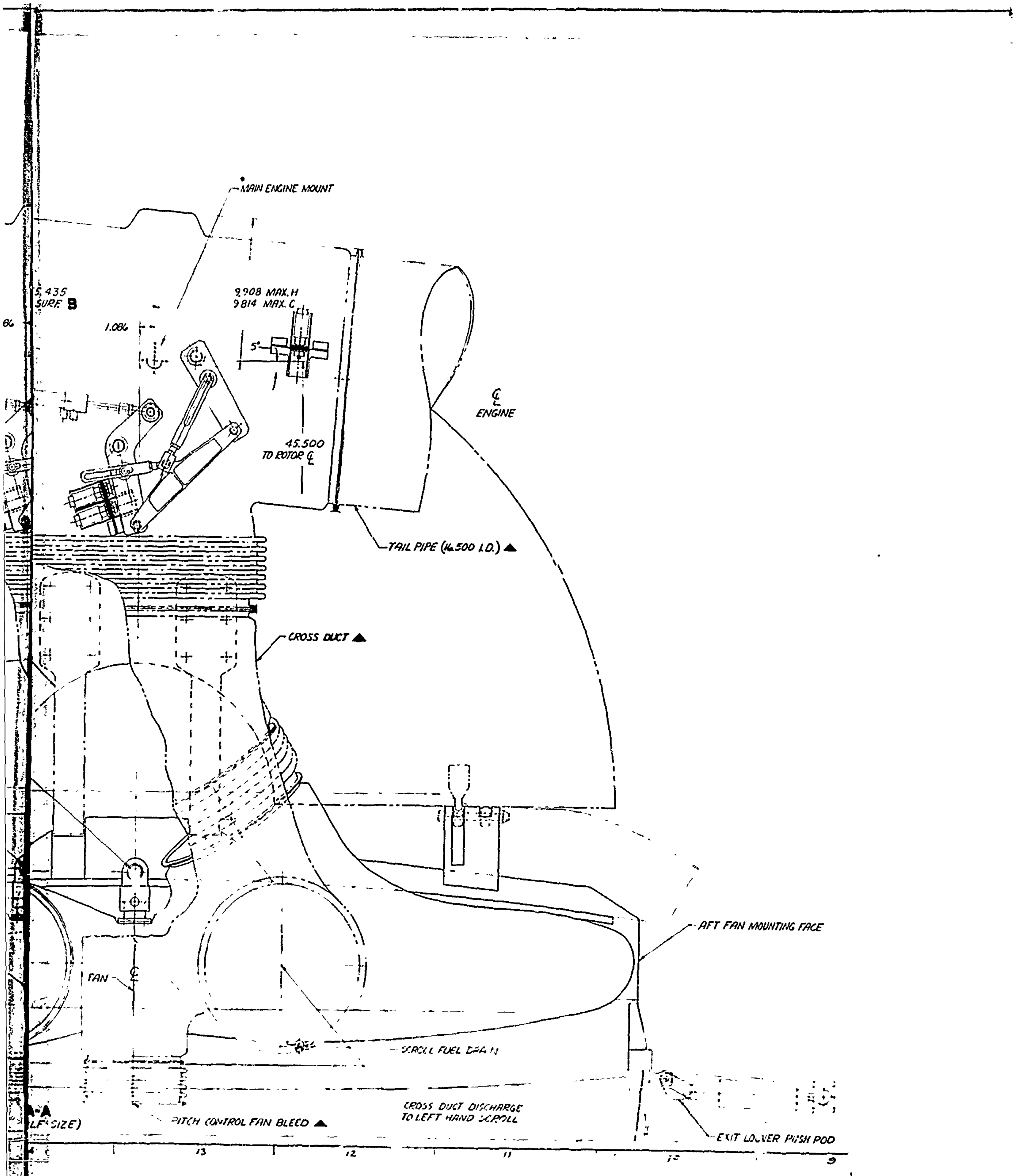

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2001-910) Sheet 2 of 3

B

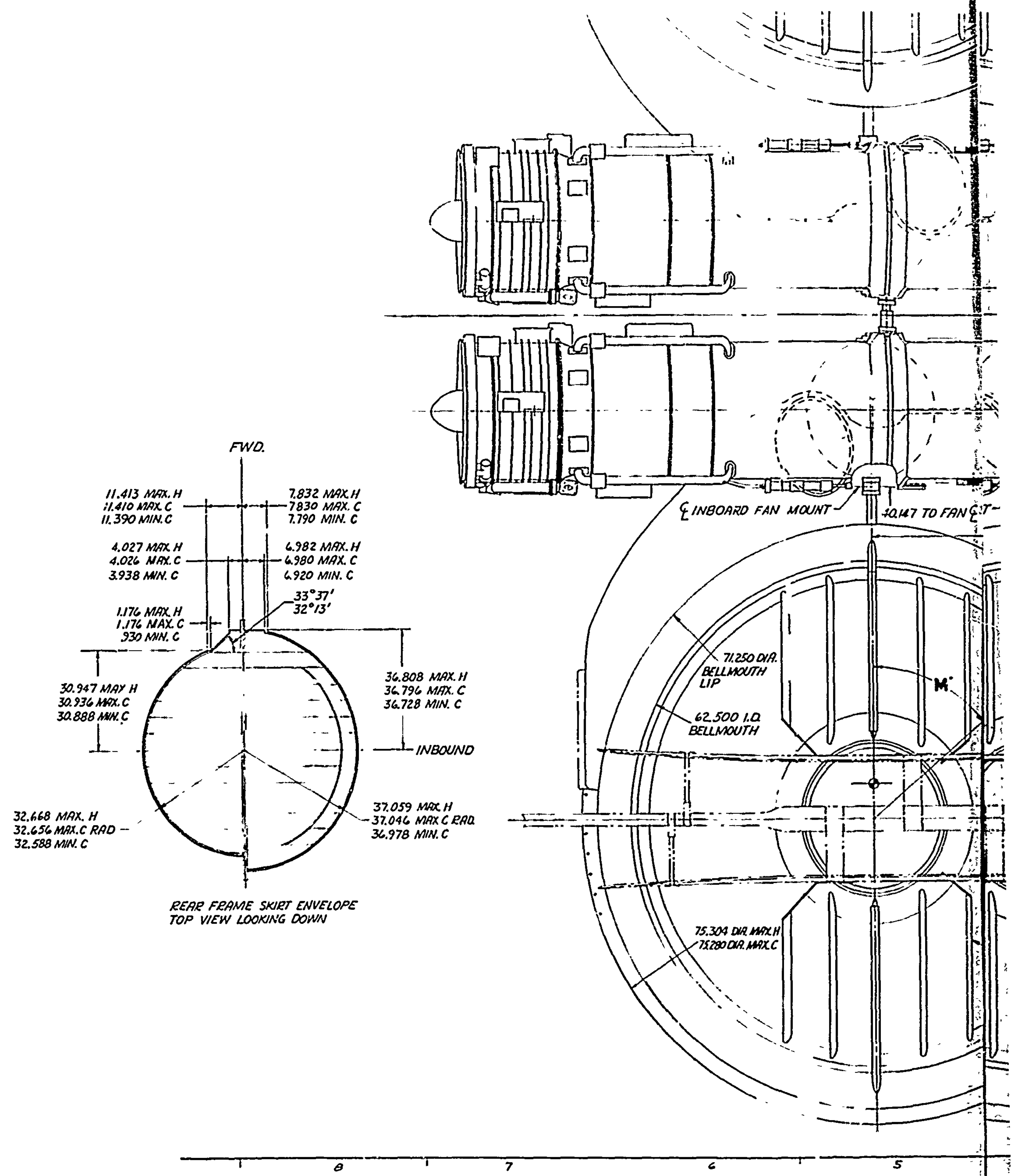

FIGURE 9.1 X353-5B SYSTEM 353
(4012001-910) S01

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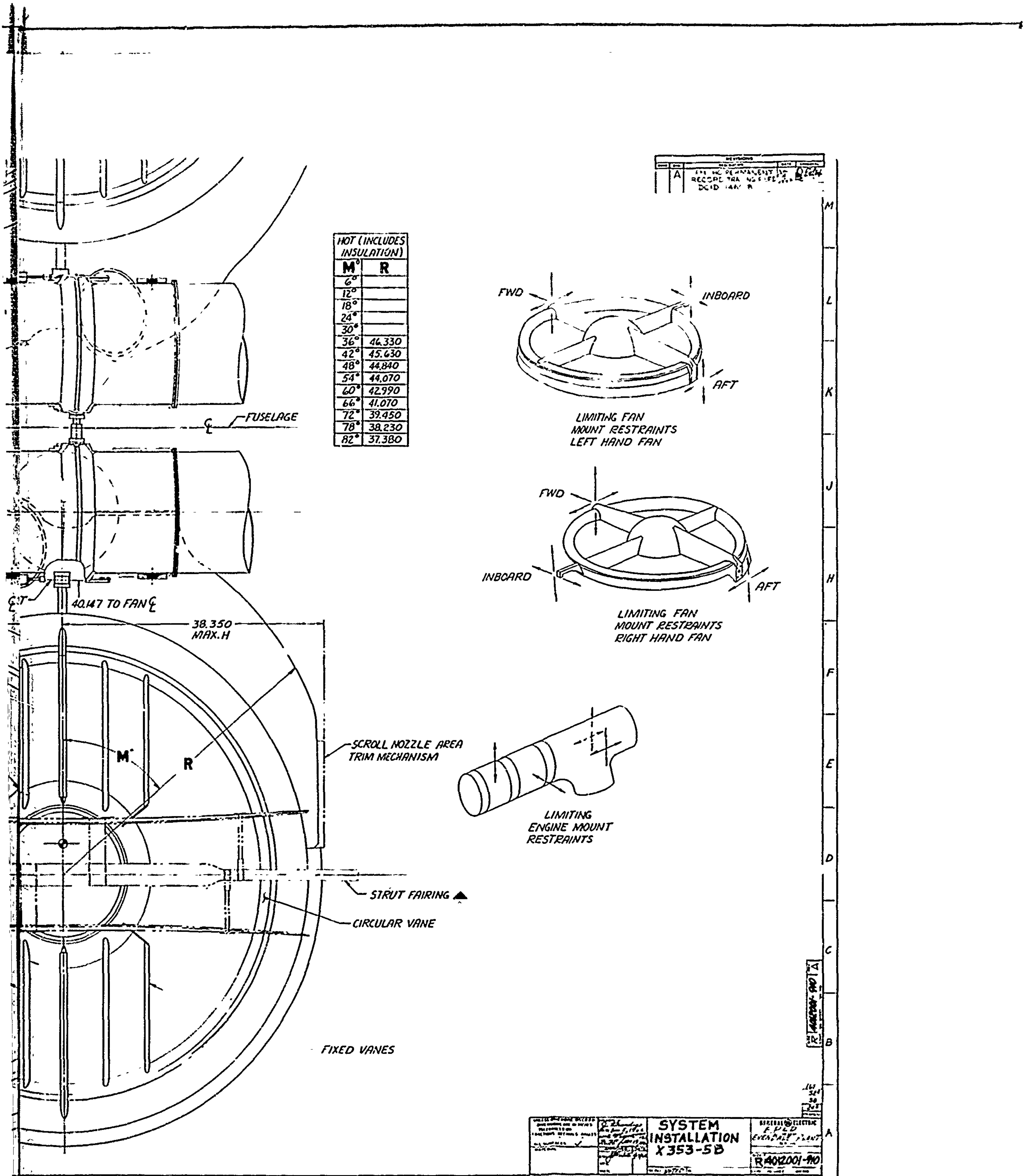

HOT (INCLUDES INSULATION)	
M°	R
6°	
12°	
18°	
24°	
30°	
36°	46.330
42°	45.630
48°	44.840
54°	44.070
60°	42.990
66°	41.070
72°	39.450
78°	38.230
82°	37.380

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ILLUSTRATIONS

FIGURE	TITLE	PAGE

SECTION 1.

INTRODUCTION

1.1 GENERAL

a. This publication, prepared by the General Electric Company, includes installation, operation and maintenance instructions for the X376 pitch trim control fan for V/STOL aircraft. This control fan was designed and is manufactured by the General Electric Company, Advanced Engine and Technology Department, Evendale, Ohio.

1.2 SCOPE

a. The X376 pitch trim control fan (Figure 1.1) derives its power from turbine discharge bleed of J85-GE-5 turbojet engines (less afterburners). The X376 is a partial admission tip turbine-driven fan which is connected to the J85 engines through airframe-provided ducting. The fan employs two separate scrolls containing the turbine inlet nozzles; this feature provides for one-engine-out operation. Reference to the J85 in this publication will be limited to special requirements of the X376 control fan. Additional information on the J85 engine can be obtained from the Small Aircraft Engine Department, General Electric Company, Lynn, Massachusetts.

1.3 REPLACEMENT OF PARTS

a. Only General Electric Class I, Ia, II or IIa parts are acceptable for use on any X376 pitch trim control fan. Replacement parts can be obtained only through the General Electric Company. Inquiries should be directed to:

General Electric Company
Advanced Engine and Technology Department
Lift Fan Systems Operation
Building 501B, Cincinnati 15, Ohio

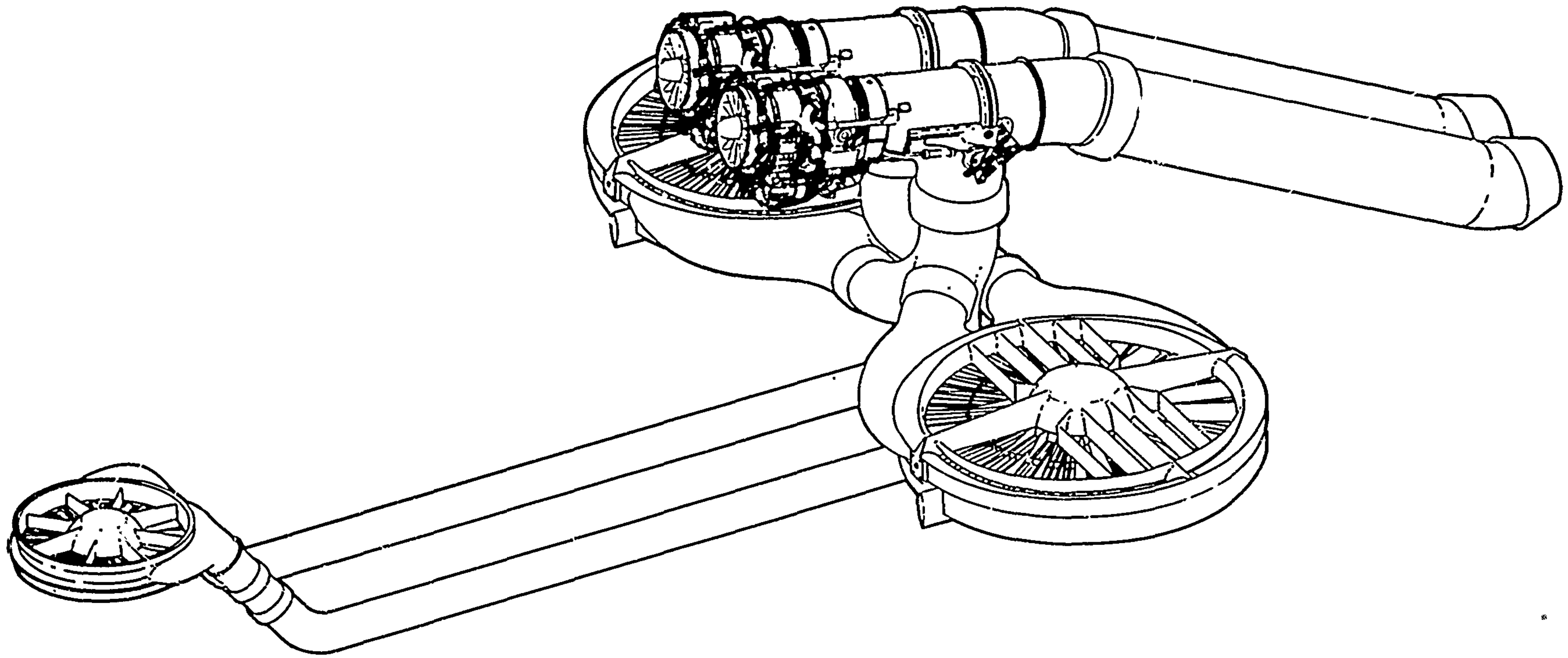


FIGURE 1.1 X376 PITCH TRIM CONTROL FAN SYSTEM

SECTION 2.

SYSTEM DESCRIPTION

2.1 GENERAL

a. The X376 pitch trim control fan is designed for installation in the nose of an aircraft (Figure 2.1). The pitch fan controls the flight attitude of an aircraft during VTOL operation by providing forces for pitch-up and pitch-down moments as required for steady, dynamic and maneuvering flight modes.

b. The X376 fan is designed to be coupled pneumatically to J85-5 gas generators and is operated only during VTOL flight mode. The input power represents a constant percent bleed of the gas generator turbine discharge, the level of which is established by adjustment of nozzle area in the pitch fan gas inlet scrolls. The ducting which connects the gas generators and the scrolls is provided as part of the airframe and can incorporate special bleed valving to shut down the pitch fan during the VTOL flight mode, if desired. The ducting design should incorporate interconnection features which enable the fan to operate with one gas generator shut down; two separate scrolls are provided to enhance efficient ducting arrangements. Consultation with the General Electric Company is recommended for reviewing all ducting and mounting arrangements.

2.2 BASIC FAN DESCRIPTION

a. The major components of the X376 pitch trim control fan (refer to Figure 4.1) include a single-stage axial-flow fan, a power turbine attached to the fan blade tips, a front frame with a bearing housing for complete support of the rotor, a rear frame containing exit stators for the fan and turbine, and a scroll which contains the partial admission turbine nozzle. Inlet and exit closure systems are provided as part of the airframe; the exit closure can be a combination closure, throttling and thrust reversing device to provide force variation. Aerodynamic design for such devices can be provided by the General Electric Company. The leading system particulars are listed in Table 2.1.

TABLE 2.1

LEADING SYSTEM PARTICULARS

Type of System	Tip turbine fan
Type of Compressor	Single-stage, axial flow
Type of Turbine	Single-stage, impulse, partial admission, attached to fan blade tips
Direction of Rotation	Clockwise (viewing from top looking down)
Rotor Speed (Max. Cont.)	4481 RPM = (110%)
Installed Dimensions	(Ref. Dwg. 4012001-913)
Dimension A	43.42" Nominal (hot)
Dimension B	43.19" Nominal (hot)
Depth at Hub	11.48" Nominal
Depth at Edge	8.26" Nominal (frame)
	11.50" Nominal (scroll)
Weight (Maximum)	120 lbs. (includes instrumentation)
Center of Gravity	1.75" above rotor centerline, 2.27" from fan centerline on aft strut
Mounting	Three point: at aft point between scrolls and on both sides of fan

2.3 SYSTEM ORIENTATION

a. Location references used in this text are shown in Figure 2.2. Similar components located on a common diameter around the fan are numbered starting with #1 at the 12 o'clock position and proceeding in a clockwise direction. The 12 o'clock position is the forward point of the fan in relation to the nose of the aircraft. Fan rotation is clockwise viewing from the top looking down. References to the forward end of the pitch fan pertain to the inlet or top side; references to the aft end of the pitch fan pertain 'ıe exit or bottom side.

2.4 ROTOR COMPONENT DESCRIPTION

a. The fan rotor component (Figure 2.3) is a single-stage, axial-flow compressor which pumps air downward to produce lift. The rotor consists of a disc, 36 blades, two blade retainer rings, a torque band, and 18 turbine bucket carrier segments which include an aerodynamic seal lip between the compressor and turbine and a tip turbine seal.

2.5 Disc Description

a. The hollow rotor disc consists of two cones machined from titanium. The two cones are rough machined and the mating surfaces at the rim and hub are ground to obtain a precision fit. The mated halves are match drilled and reamed to obtain an interference fit for the 36 body bound bolts located at the disc rim. In addition, six holes are drilled through the flanges inside the hub to accommodate six bolts and nuts. The dovetail slots are broached and the inside diameters of the hub are finish ground to provide a surface for the bearing outer races.

b. The rotor disc appears symmetrical. However, the forward or inlet side of the disc can be identified by nine equally spaced vent holes (0.062") which are drilled through the face of the forward disc around the outer circumference.

c. The 36 body bound bolts located around the rim of the disc are machined from AMS 6415E steel, hardened to Rc 38 to 40, and finished with a black oxide coating.

d. Scalloped flanges on the forward and aft sides of the disc near the hub contain eight holes for attachment of the grease seal retainers.

e. The wedge-shaped spacers (Figure 2.4-C) which are assembled to the rim bolts on the forward and aft faces of the disc are machined from titanium bar stock. One face of the spacer is machined at an angle of 15° to provide a seating surface which is perpendicular to the center line of the rim bolt. A square shoulder is machined on the opposite face to fit the slot in the blade retainer rings.

f. Spacers are also machined from L605 stainless steel in a configuration identical to that described above. The spacers machined from L605 material are approximately twice as heavy as those machined from titanium and are used as balance weights at assembly.

2.6 Blade Retainer Rings

a. Each rotor assembly has two retainer rings; one forward and one aft. Both rings are formed with a U-shaped cross section from 0.020" titanium sheet. The configuration of the rings is similar but they are not identical. The lips on the forward retainer are about 5/16" high. The lips on the aft retainer have different heights; the lip around the inner diameter is about 5/16" high, the lip around the outer diameter is about 9/16" high. In addition, the aft retainer has 36 equally spaced slots machined through the outer lip to provide clearance for the rotor blade platforms. Each retainer ring has 36 square holes pierced through the surface which mate with the rim of the rotor disc; the sides of these holes provide a seat for shoulders on the wedge-shaped spacers.

2.7 Rotor Blade Description

a. The rotor has 36 blades which pump air downward to produce lift.

The blades have a tapered section airfoil. The dovetail, platform, airfoil, and tip tang are machined as an integral piece from an oversized forging or a hot rolled bar of titanium. The blade dovetail has a single hook which is shot peened and coated with graphite after final machining. The blade tip tang (Figure 2.5-B) provides a hole for a bolt attachment of the blade to the turbine bucket carrier at assembly.

2.8 Torque Band Description

a. The torque band (Figure 2.5-B) is assembled over the blade tip tangs and is bolted to the turbine bucket carriers. The torque band transmits torque from the exposed portion of the partial admission turbine to the blades which are out of the partial admission arc. The band is formed from 0.025" Rene 41 sheet; the ends of the band are butt welded to form a continuous ring which is age hardened to RC 35-43. Thirty-six slots and a total of 48 holes are located around the circumference of the band. Eighteen of the holes contain a grommet (made of Rene 41) which is press-fitted to the band; this grommet matches a hole located near the center of the span of the carrier assemblies. When assembled to the torque band, each carrier segment spans two blade tip tang slots, two plain holes, and one grommeted hole.

2.9 Bucket Carrier Description

a. Each rotor assembly has 18 turbine bucket carrier segments (Figure 2.5-A). Each segment consists of a seal which forms the outer flow path through the compressor, a carrier which serves as the link between the compressor blades and the turbine, and 14 turbine buckets and tip shrouds. The components are manufactured from Inconel X material and are brazed together to form a permanent assembly.

b. The carrier seal is located on the innermost radius of the carrier. It is machined from bar stock. Three anchor nuts are riveted to the outer circumference of the seal to provide attachment to the torque band.

c. The carrier section has two side rails which are formed from 0.016" sheet. The side rails are re-inforced internally with four side plates which are machined to 0.125" thickness. Four external doublers and a box section which forms the inner flow path through the turbine are formed from 0.011" sheet.

d. The turbine buckets are formed from seamless tubing having an 0.008" wall and having an internal re-inforcing rib of 0.008" sheet. The turbine tip shrouds are also formed of 0.008" sheet.

2.10 Bolt, Blade-to-Carrier

a. The body bound bolt which attaches the blade tip tang to the carrier is machined from B50T59A steel and age hardened to Rc 35-43. The bolt is manufactured in five sizes ranging from 0.2405" to 0.2505" in increments of 0.0002" to provide a select fit at assembly.

2.11 Bolt, Torque-Band-to-Carrier

a. The torque-band-to-carrier bolt is machined from B50T12A steel and is hardened to Ra 64-68.

2.12 FRONT FRAME DESCRIPTION

a. The front frame assembly (Figure 2.6) forms part of the aerodynamic flow path to the rotor inlet and serves as the mounting and support structure for all other pitch fan components.

b. The basic components of the front frame assembly are the frame, the bulletnose hub cover, the rotor shaft, and the rotor bearing system.

2.13 Frame Description

a. The basic structure of the front frame is machined from a magnesium casting and is anodized after machining. The frame consists of a hub, eight airfoil-shaped struts, and an outer ring. The inside diameter of the hub is precision machined to provide an interference fit for the rotor shaft. Four holes drilled through the forward end of the hub receive bolts to attach the rotor shaft to the front frame at assembly; a zinc-plated cover of 0.020" AMS 5510 steel is assembled to the forward end of the hub to provide a washer surface for these bolts. A boss machined through the aft flange of the hub positions the speed sensor boss.

b. The frame has eight airfoil-shaped struts; four of these are major struts, four are minor. The hollow major struts are located at the 12, 3, 6, and 9 o'clock positions. The minor struts are located at the 1:30, 4:30, 7:30, and 10:30 o'clock positions. Mounting pad bosses are machined on the face of the outer ring at the extremity of each strut except for the minor struts at the 1:30 and 10:30 o'clock positions. The major strut at the 12 o'clock position can be identified in several ways: 1) it is located between the two minor struts which do not have mounting pad bosses; 2) a hole to receive instrumentation leads is drilled through the side wall of the strut near the hub; and 3) the speed sensor boss is machined in the hub at the 1:00 o'clock position.

c. The scalloped aft flange of the outer ring contains a bolt circle of 52 equally spaced holes for attachment to the rear frame cover, the forward air seal and the scroll seal lip. The radial holes drilled through the forward end of the outer ring provide attachment to support the rear frame cover. The rabbet machined on the O.D. at the forward end of the outer ring provides a slip fit alignment for the bellmouth. The outer bellmouth is an airframe part.

d. The bulletnose dome is formed from 0.032" aluminum sheet. The dome is reinforced with an internal doubler formed of 0.032" aluminum. The doubler is flush riveted to the outer skin. A flange formed of 0.032" aluminum is flush riveted to the aft end of the dome. Eight anchor nuts riveted around the hole near the forward end of the dome provide attachment for the dome cover plate. The dome cover plate is also formed of 0.032" aluminum. The bulletnose assembly is fastened to the frame struts with 0.032" aluminum clips and rivets.

2.14 Shaft

a. The hollow rotor shaft (reference Figure 2.4-B) is rough machined from AMS 6415E steel, heat treated to Rc 38-40, and finish machined. Four outside diameters of the shaft are precision ground. Two of the ground surfaces located near the forward (or closed) end of the shaft are zinc plated and provide an interference fit upon assembly to the front frame. The two ground surfaces near the aft (or open) end of the shaft provide a seat for the bearing inner races. Four shank nuts are swaged to four holes inside the forward end of the shaft to provide attachment to the front frame. Eight shank nuts are swaged to the flange at the aft end of the shaft to provide attachment to the rear frame cover plate.

2.15 Bearing System

a. A two-bearing system consisting of a ball thrust bearing and a roller bearing, supports the over-hung rotor. The bearings are mounted to the shaft which extends from the front frame hub. The roller bearing is assembled to the forward end of the shaft; the roller bearing is assembled to the aft end of the shaft. The balls, rollers, and races are made of 52100 steel; the cage material is silver plated bronze.

b. Both bearing inner races are press fitted to the rotor shaft at assembly. The inner races are separated by a spacer which is machined from titanium. Both outer races are press fitted to their respective housings in the hub of the rotor disc.

c. The ball thrust bearing has a split inner race. The forward half of the split inner race contains a puller groove. The bore diameter of the ball bearing is 3.9350" - 3.9361". The tolerance of the bearing is ABEC-5 grade (aircraft quality). It contains 14 balls which are 0.5625" diameter. The ball bearing is designed to give 600 hour B10 life at a maximum temperature of 300°F when lubricated with grease.

d. The roller bearing bore diameter is 3.9350" - 3.9361". The bearing has a tolerance of ABEC-5 (aircraft quality). It contains 20 rollers which measure 0.3937" long by 0.3937" diameter. The roller bearing is designed to give 600 hour B10 life at a maximum temperature of 300°F when lubricated with grease.

e. Both rotor bearings are lubricated with a Uni-Temp 500 grease at assembly. The system does not require an oil supply, pumps or lines.

2.16 Retainer, Roller Bearing

a. The roller bearing retainer is machined from titanium. The scalloped flange contains eight equally spaced holes for bolt attachment to the aft side of the rotor disc to retain the roller bearing outer race and grease seal.

2.17 Retainer, Ball Bearing

a. The ball bearing retainer is machined from titanium. The lip extending from the inner diameter holds the ball bearing outer race and grease shield. The scalloped flange contains eight equally spaced holes for attachment to the forward face of the disc. The retainer also holds the rotor speed generator disc in place.

2.18 Grease Seals

a. The pitch fan rotor has three grease seals; one on each side of the ball bearing, and one on the aft side of the roller bearing. Construction of all three seals is similar. The seal material (Viton Fluro Elastomer) is bonded to the metal backup plate which is machined from AMS 5510 steel. The inside diameter (seal material) of the roller bearing seal is slightly larger than the ID of the ball bearing seals.

2.19 Grease Shield

a. A grease shield machined from AMS 5504 steel is located on the forward side of the roller bearing.

2.20 Spacer, Front Frame to Ball Bearing

a. The spacer (Figure 2.4-A) adjusts the height from the front frame to the ball bearing inner race. The spacer is furnished in two different thicknesses: 0.108" and 0.158"; the proper thickness is determined at assembly. The spacer is machined from AMS 5504D steel and is zinc plated on one side only. This plated side is assembled to the magnesium front frame.

2.21 Speed Generator Disc

a. The rotor speed generator disc (reference Figure 2.4-C) is sandwiched between the roller bearing retainer and the forward face of the rotor disc. The disc is machined from AMS 6415E steel. It contains 60 equally spaced teeth which are "counted" by the speed sensor.

2.22 Magnetic Sensor - Rotor RPM

a. The magnetic rotor speed pickup sensor (Figure 2.7-B) is mounted to a boss machined in the aft flange of the front frame hub. The pickup reluctance is varied by a toothed disc mounted to the rotor shaft. The coil, winding, spool, and magnet are equivalent to Electro Products, Inc., Model 3015 HTB. The shell material is AISI 416 stainless steel. The sensor is capable of operating at temperatures ranging from -65°F to +450°F.

b. The sensor is mounted to the front frame by means of a threaded bushing and two nuts. The bushing and nuts are machined from AMS 4120 aluminum and are anodized. A stainless steel pin (0.063" diameter) is press fitted to the aft flange of the bushing. The pin fits a hole in the aft face of the sensor and prevents translation during fan operation. The height of the speed sensor in relation to the generator disc is controlled by the insertion of spacers between the forward end of the bushing and the shoulder on the sensor. The spacers are machined from AMS 4035 aluminum to thicknesses ranging from 0.030" to 0.034".

2.23 Mount - Front Frame to Rear Frame (6 o'clock)

a. The front frame to rear frame mount (Figure 2.8-A) provides support for the rear frame at the 6 o'clock position. This mount is bolted to the front frame between the adjacent scroll ends. the outer end of the mount contains a bolt hole for attaching the support arm which extends from the mount to the rear frame. All parts of the mount are formed from

Hastelloy X sheet and are welded as a permanent assembly. The side plates, stiffeners and gussets are 0.032" thick; the washers around the four mounting holes in the base plate are 0.145" thick.

2.24 Support - Front Frame to Rear Frame (6 o'clock)

a. The front frame to rear frame support arm (Figure 2.8-A) extends from the mount on the front frame (at the 6 o'clock position) to two pads welded to the outer skin of the rear frame. The support arm is made of Hastelloy X material and is welded as a permanent assembly. The base plate is 0.032" thick; the lug which fastens to the front frame mount is machined from bar stock and welded in place. The washers which are welded to the tabs are 0.063" thick.

2.25 Support - Front Frame to Rear Frame

a. Eight sheet metal support members (Figure 2.8-B) extend from the forward end of the front frame to the rear frame cover and in turn to the forward flange of the rear frame to provide support to the rear frame in the inactive portion of the turbine. The body of the support members (0.015" Inconel X sheet) and the end caps (0.032" Inconel X) are welded as a permanent assembly.

2.26 AIR SEAL - ROTOR

a. The rotor air seal (refer to Figure 2.7-B) consists of 26 segments which are bolted to the aft flange of the front frame to provide a seal between the compressor and turbine flow paths. The seal is constructed of AMS 5536 sheet metal and honeycomb fabricated of 0.003" AMS 5510. The cells in the honeycomb are 0.125" hexagonals; the height of the honeycomb is ground to final dimension during the initial assembly process. The backup plate which supports the honeycomb is 0.020" thick; the top flange and the end tab are 0.016" thick. Each sector (or segment) has three holes through the flange equally spaced on a basis of 52 holes; the two end holes are elongated to permit thermal expansion during operation of the fan.

2.27 REAR FRAME

a. The rear frame (Figure 2.9) supports the stator vanes for the fan and turbine, provides turbine bucket tip clearance control and supports a cover plate over the inactive portion of the turbine. It also provides for the attachment of the outer scroll air seal. The separate parts of the rear frame are made of Inconel X material; these are brazed to form a permanent assembly. The major components of the rear frame are the center hub; an inner box located at the juncture of the hub and compressor stator vanes; 52 compressor stator vanes; a support ring at the mid span of the compressor vanes; a middle box at the juncture of the compressor and turbine vanes; 27 turbine stator vanes; the outer shell (or turbine casing); and a cover plate which seals off the inactive portion of the turbine stator.

b. The innermost member of the rear frame is formed from two 0.010" thick cone shaped discs. The outer edges of these cones are used to form the upper and lower sides of the inner box. The two side walls are made from rings formed from 0.010" thick sheet which are welded and brazed to the cones. At the inner edge of the cones, 16 shank nuts are provided for retaining a dish shaped cover ring.

c. The compressor stator vanes are hollow structures and have a constant airfoil section. The outer skin of the vanes is formed of 0.010" material. Each vane has an internal U-shaped stiffener of 0.010" material and an insert made of 0.040" material at each end. The vanes are welded at the trailing edge. A flat ring formed of 0.015" sheet supports the vanes at the center of the span. In the inactive portion of the turbine, 14 compressor vanes extend through the turbine to the outer skin of the casing and act as support members.

d. The middle box at the juncture of the compressor vanes and turbine vanes is formed of 0.010" sheet. The ends of the compressor vanes and turbine vanes extend through both walls of the middle box.

e. The turbine has 27 stator vanes which are hollow structures formed of 0.015" sheet; each vane has an internal U-shaped stiffener of 0.015" material and a cap made of 0.040" sheet inserted at each end. The turbine stator vanes have a constant airfoil section and have no twist.

f. The outer skin, or turbine casing, i formed of 0.010" sheet. The forward and aft flanges are welded to the outer skin and machined to final dimensions. Sawcuts through the outer skin and flanges permit thermal expansion of the casing. The sawcuts are covered with hat sections formed of 0.010" sheet which provide a gas seal and support the turbine and compressor vane ends. Six bosses located on the outer skin of the casing accommodate bolts to fasten three support arms which extend from the rear frame to the inlet scroll mounting pads. Twenty-five gussets formed of 0.010" sheet are brazed to the outer surface of the casing and the forward flange to provide support in the cold or inactive portion of the turbine stator.

g. The cover which seals off the inactive portion of the turbine stator exit is formed of 0.010" sheet and is fastened to the outer skin with a 0.020" stiffener.

h. The dish-shaped cover at the hub of the rear frame is formed of 0.063" aluminum. The cover has one circle of bolt holes. Three holes around the outer circumference accommodate bolts for attachment of the cover to the rear frame.

2.28 INSULATION BLANKET - REAR FRAME

a. The rear frame insulation blanket is assembled around the outer circumference of the rear frame. The blanket is made in nine sections. The insulating material is sandwiched between two sheets of 0.003" stainless steel which form the outer skin. Buttons protrude from the outer skin for lockwire fastening at assembly. The blanket covers the entire height of the rear frame inactive portion of the turbine and covers only the lower half in the active portion.

2.29 COVER - FRONT FRAME TO REAR FRAME

a. The front frame to rear frame cover extends over the closed portion of the partial admission turbine. The cover is constructed of Inconel X sheet which is formed and welded around an insulating filler material. The bottom sectors are made of 0.010" sheet; the flange along the ID is 0.010" thick; the flange around the OD is 0.015" thick. The top cover (including the cap over the eight recesses) is formed of 0.003" sheet and is reinforced with internal hat section stiffeners of 0.010" material. The end support plate at the 3 o'clock position is 0.010" thick; the end plate at the 9 o'clock position is 0.015" thick. Both flanges contain sawcuts to permit thermal expansion.

2.30 TURBINE INLET SCROLL

a. Each pitch control fan has two turbine inlet scrolls (Figure 2.10) which accept exhaust gas from the gas generators and direct it through the nozzle diaphragm and into the turbine. The two inlet scrolls are identical.

b. The major components of the scroll are the outer shell and inlet section, the nozzle diaphragm, and the mounting pads. All components are made of Hastelloy X material and are brazed or welded into a permanent assembly.

c. The outer shell of the scroll is formed of 0.015" sheet. The inlet flange is rough machined from a forging, welded in place and finish machined. A triangular-shaped airfoil strut provides internal support at the inlet. The external hat section stiffeners are formed of 0.015" sheet; these are reinforced internally with 0.015" gussets. Eyeleted vent holes are pierced through the skin under the hat sections. Ten airfoil-shaped internal support struts are machined from bar stock. The struts extend through the skin of the scroll and are reinforced at the ends with hat sections. Twelve bosses machined from bar stock project from the outer skin; the four bosses located on top of the scroll are reinforced with a 0.032" doubler, the remaining eight bosses are supported by hat sections. These bosses accommodate installation of blankoff plates which are used to adjust the flow of gas through the inlet scroll and into the nozzle.

d. The mounting plates at each end of each scroll (Figure 2.11-A) are machined to a minimum thickness of 0.050". The mounting plate support members and the scroll end plate are formed of 0.020" sheet. The center mount bracket (top-scroll-to-front-frame) is machined from bar stock; (refer to Figures 2.10 and 2.13) the bracket and 0.063" side plates are welded in place. The scroll-to-rear-frame mounting boss, located under the scroll inlet (refer to Figure 2.10-B), is machined from bar stock; the boss and its supporting hat section of 0.015" sheet are welded to the scroll.

e. The nozzle partitions are machined from bar stock. They have a constant airfoil section and have no twist. The ends of the partitions project through the scroll walls and are brazed in place. The seal lips around the periphery of the nozzle exit are formed of 0.015" sheet.

2.31 SCROLL BLANK OFF PLATES

a. The scroll blank-off plates (Figure 2.11-B) are assembled inside the scroll during initial assembly as required to reduce nozzle area and control the flow of hot gas to a desirable level. The blank-off plates are formed of 0.032" Hastelloy X sheet to a cup shape with the outer contour conforming the shape of the scroll. Three lugs welded inside the cup are match drilled to the bosses in the outer skin of the scroll. A fourth lug welded at the center of the cup is used for assembly purposes.

2.32 INSULATION BLANKET - SCROLL

a. The entire outer skin of the scrolls are covered with an insulation blanket. The blankets are made in sections which contain buttons protruding from the outer skin to accommodate lockwiring at assembly. The insulating material is sandwiched between two sheets of 0.0015" thick 321 stainless steel.

2.33 SCROLL MOUNTING

2.34 Clevis

a. Each pitch control fan has four scroll mounting clevises (refer to Figures 2.8-A&B and 2.12-A) which fasten the scroll ends to the front frame. The clevises appear similar but consist of right and left hand units. The clevises used on the right end of each scroll are identical. The two can be distinguished by the location of the channel-shaped supports and their relation to the holes drilled in each of the four corners of the base plate. On the right hand unit (viewing from top looking down), the channel supports run from the top right hand corner toward the lower left hand corner in which the hole is offset. The channel supports on the left hand clevis (viewing from top looking down), run from the top left hand corner toward the lower right hand corner which contains the offset hole. The base plate and the channel support members are formed of 0.063" Hastelloy X material and are welded as a permanent assembly.

b. Shim washers (0.555" OD by 0.030" ID) are provided to adjust the height of the scroll end clevises. The shims are manufactured from 321 stainless steel in three thicknesses: 0.005", 0.010", and 0.020". These shims are also used to adjust the height of the scroll bottom center mount.

2.35 End Mounts

a. The scroll end mounts consist of a right, left, and center mount (refer to Figures 2.8-A&B and 2.12-B&C). The construction of all three mounts is similar except that the center mount contains two arms (one for each scroll end at the 6 o'clock position, refer to Figure 2.8-A). All parts are made of AMS 5643E stainless steel and are welded as a permanent assembly. The side ribs and top and bottom stiffeners are made of 0.032" sheet. The base plate is machined to a minimum thickness of 0.100". The uniball housing is machined from bar stock and contains a groove to accommodate the snap ring which locks the uniball in place.

b. Each scroll end mount has a stud which is machined as an integral part at the center of the base plate (Figure 2.12-B&C). This stud serves as the pitch-fan-to-aircraft mount. The threaded portion of the stud

(Figure 2.12-C) extends from the outer face of the mount. A lug (Figure 2.12-B) extends from the inner face and matches a boss in the face of the front frame mounting pads at the 3, 6, and 9 o'clock positions.

c. Shim plates are provided to adjust the position of the scroll end mounts. The shim is manufactured from 321 stainless steel in two thicknesses: 0.025" and 0.050".

2.36 Center Mounts

a. Each scroll has two center mounts; one at the top (Figure 2.13-A) which connects the scroll to the front frame and one at the bottom (Figure 2.14-A) which connects the scroll to the rear frame.

b. The body of the top center scroll to front frame mount (Figure 2.13-B) is machined from Inconel X bar stock. The base has four holes and a lug which match a mounting pad on the front frame (at 4:30 and 7:30 o'clock); the arm contains a uniball which fastens to the clevis at the top center of the scroll.

c. Shim plates are provided to adjust the top scroll center mount. The shims are manufactured from 321 stainless steel in two thicknesses: 0.025" and 0.050".

d. The bottom center (scroll to rear frame) mount (Figure 2.14-B) is made of Hastelloy X material. The base plate is 0.032" thick, the top plate and gussets of 0.040" material are pinned to the lug. The doubler washers welded to the tabs are 0.063". The lug is machined from bar stock.

e. A thermo gasket, consisting of an insulating gasket and a shim is assembled between the center mount and the front frame to minimize the heat flow to the front frame.

2.37 SCROLL END COVERS

a. The scroll end covers (Figure 2.15) provide a seal at the ends of the scroll arms yet permit "growth" of the arms because of thermal expansion. Each pitch control fan has three scroll end covers; one each at 3, 9, and 6 o'clock. The end covers at 3 and 9 o'clock (Figure 2.15-B) differ only in that they are right and left hand; the cover at the 6 o'clock position (Figure 2.15-A) is "double" in that it provides a seal for both scrolls at the 6 o'clock position. The base plate and cap are formed of 0.032" AMS 5536 steel; the seal spring is formed of 0.010" AMS 5542F steel and is riveted to the cap.

2.38 SCROLL SEAL SEGMENTS

a. The seal segments are assembled to the forward side of the scroll seal lips around the nozzle exit. There is a total of 18 segments; nine on the OD of the scroll and nine on the ID. The scroll seal lips are sandwiched between the seal segments and the rear frame flange on the OD of the scroll and between the seal segments and the air seal flange on the ID. The segments are made of 0.015" Inconel X sheet. The four end segments and two center segments can be identified by a notch in the OD of the inner segments and in the ID of the outer segments.

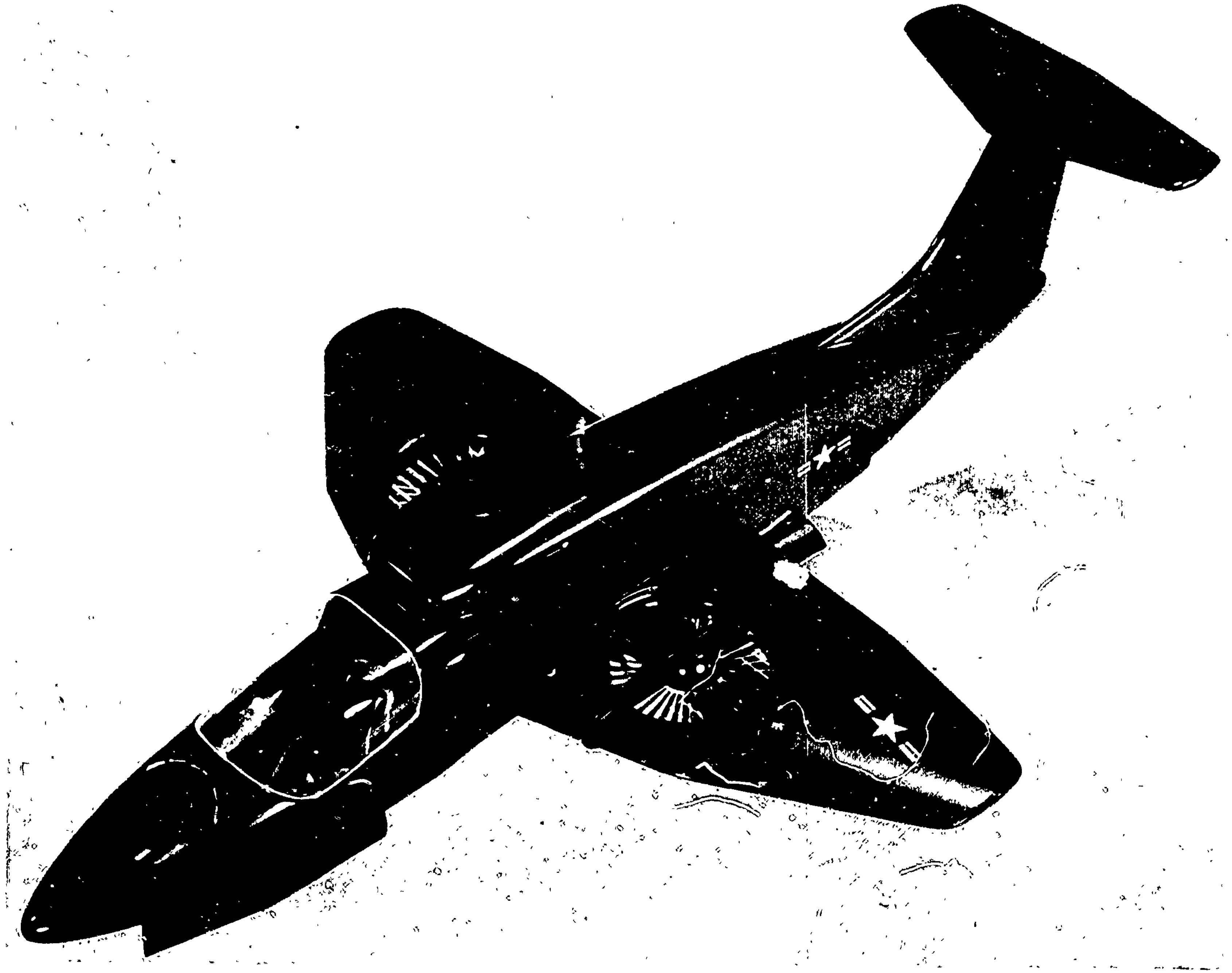
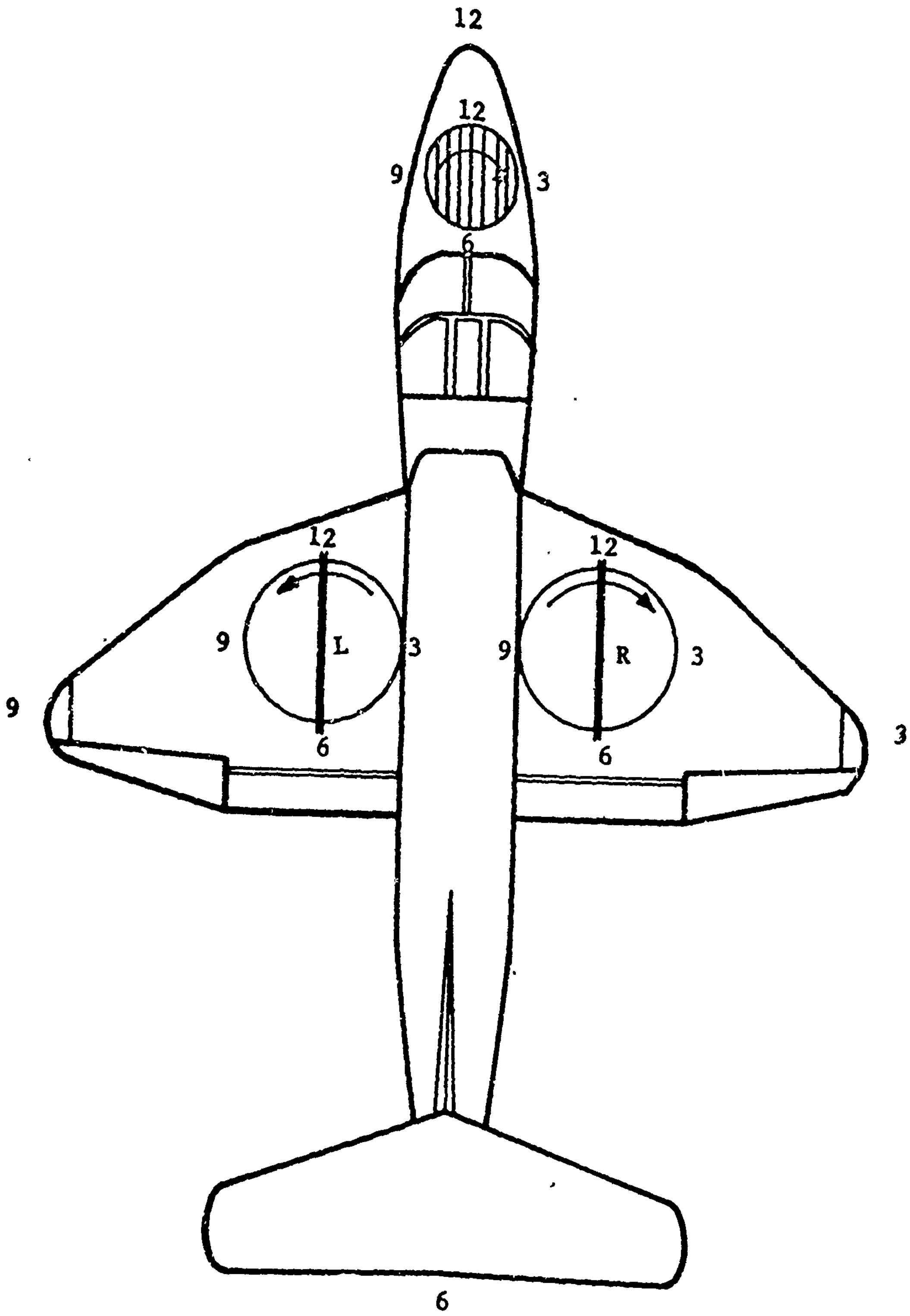


FIGURE 2.1 TYPICAL INSTALLATION OF X376 PITCH TRIM CONTROL FAN



(Top-Looking Down)

FIGURE 2.2 X376 PITCH FAN ORIENTATION

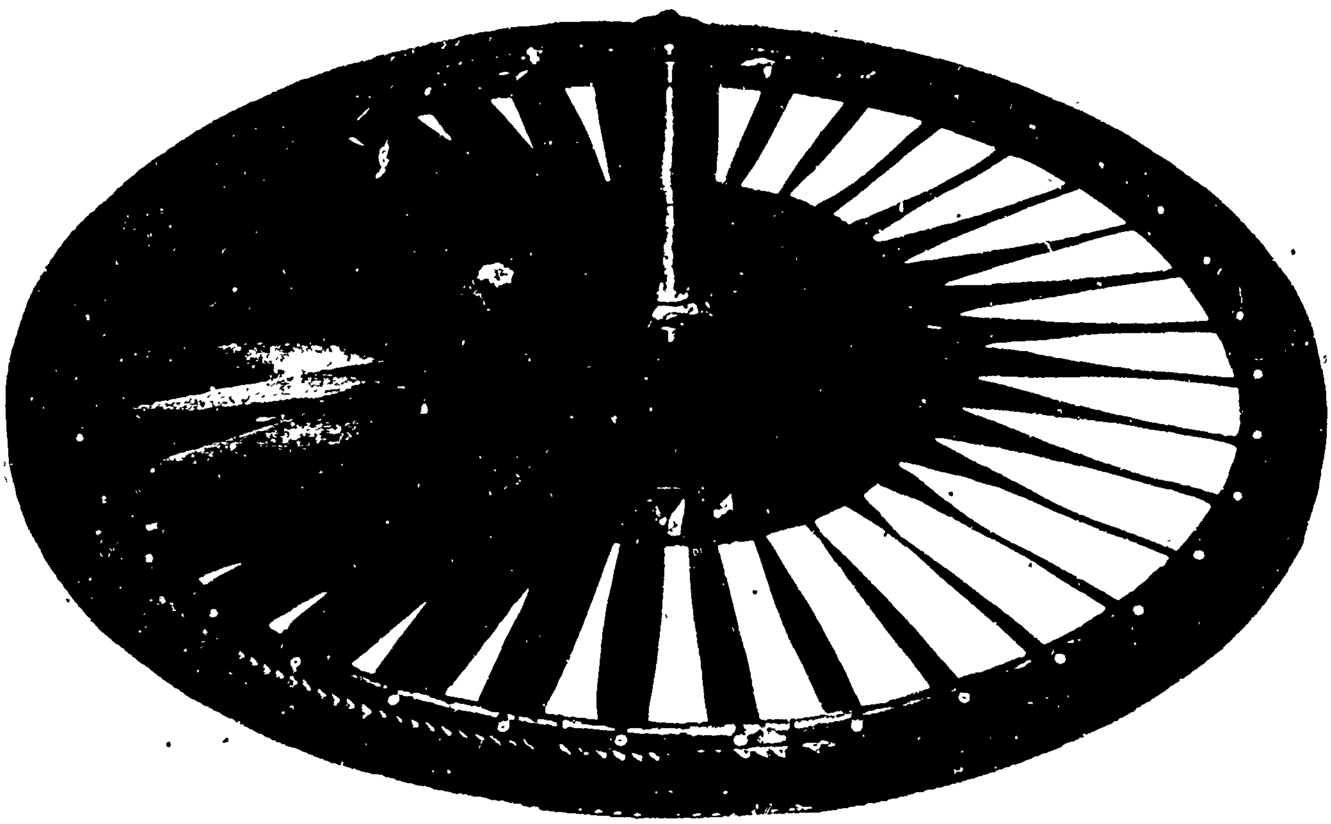


FIGURE 2.3 X376 PITCH FAN ROTOR COMPONENT

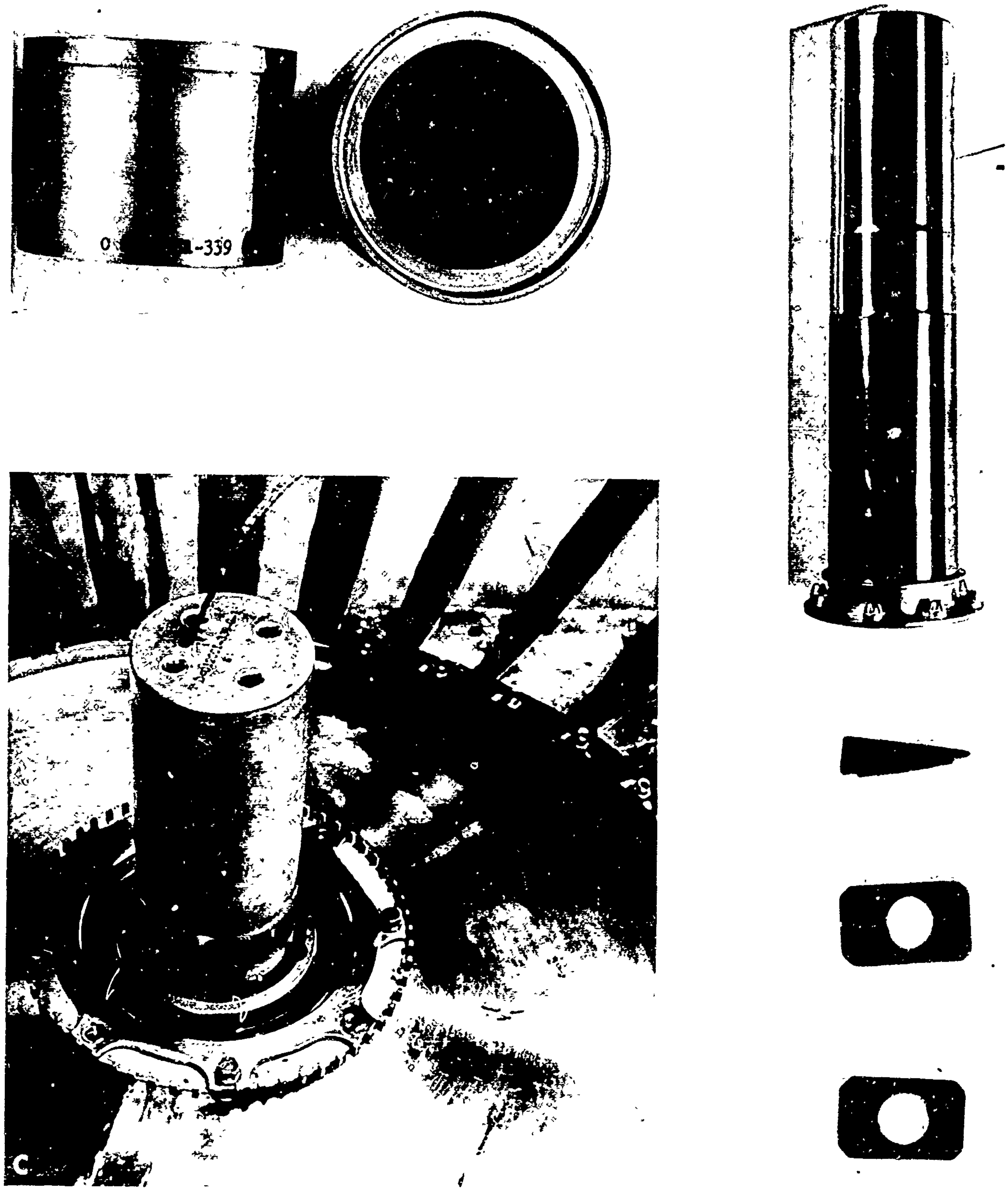


FIGURE 2.4 X376 PITCH FAN (A) BEARING SPACER, (B) ROTOR SHAFT, (C) DISC, SHAFT AND SPEED GENERATOR, (D) RIM BOLT SPACERS.

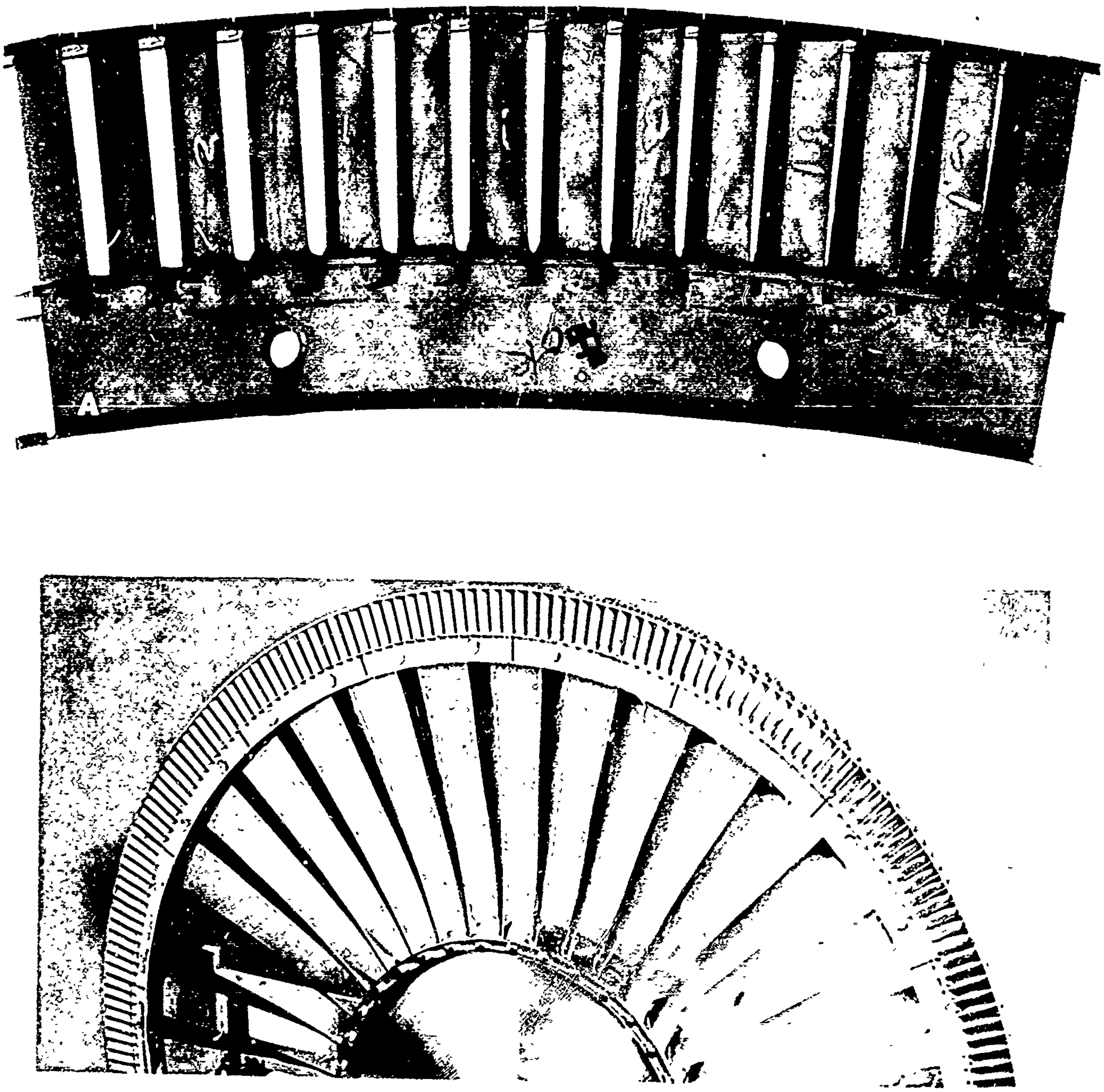


FIGURE 2.5 X376 PITCH FAN (A) CARRIER SEGMENT, (B) ROTOR BLADE TIP TANG AND TORQUE BAND

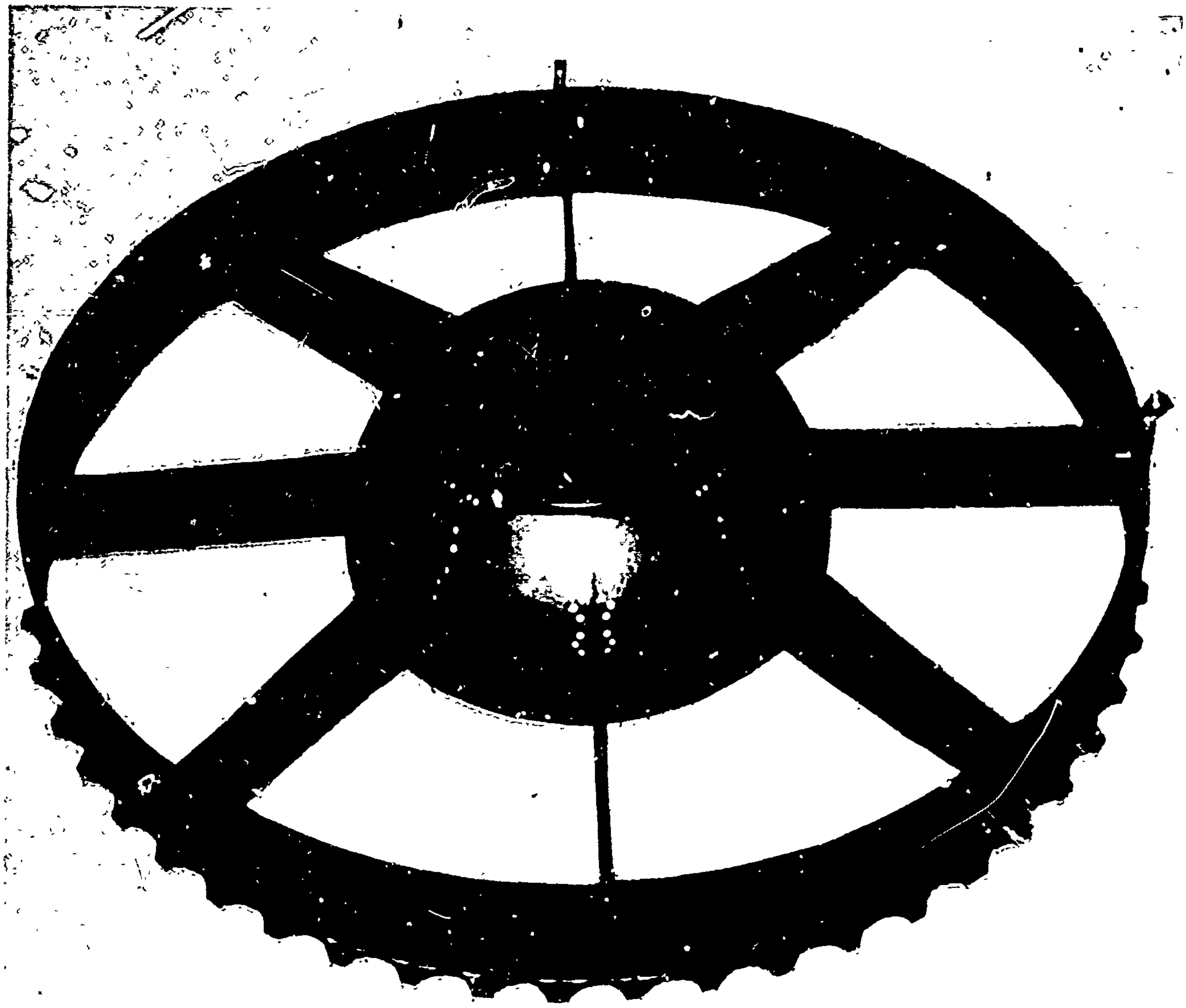


FIGURE 2.6 X376 PITCH FAN FRONT FRAME

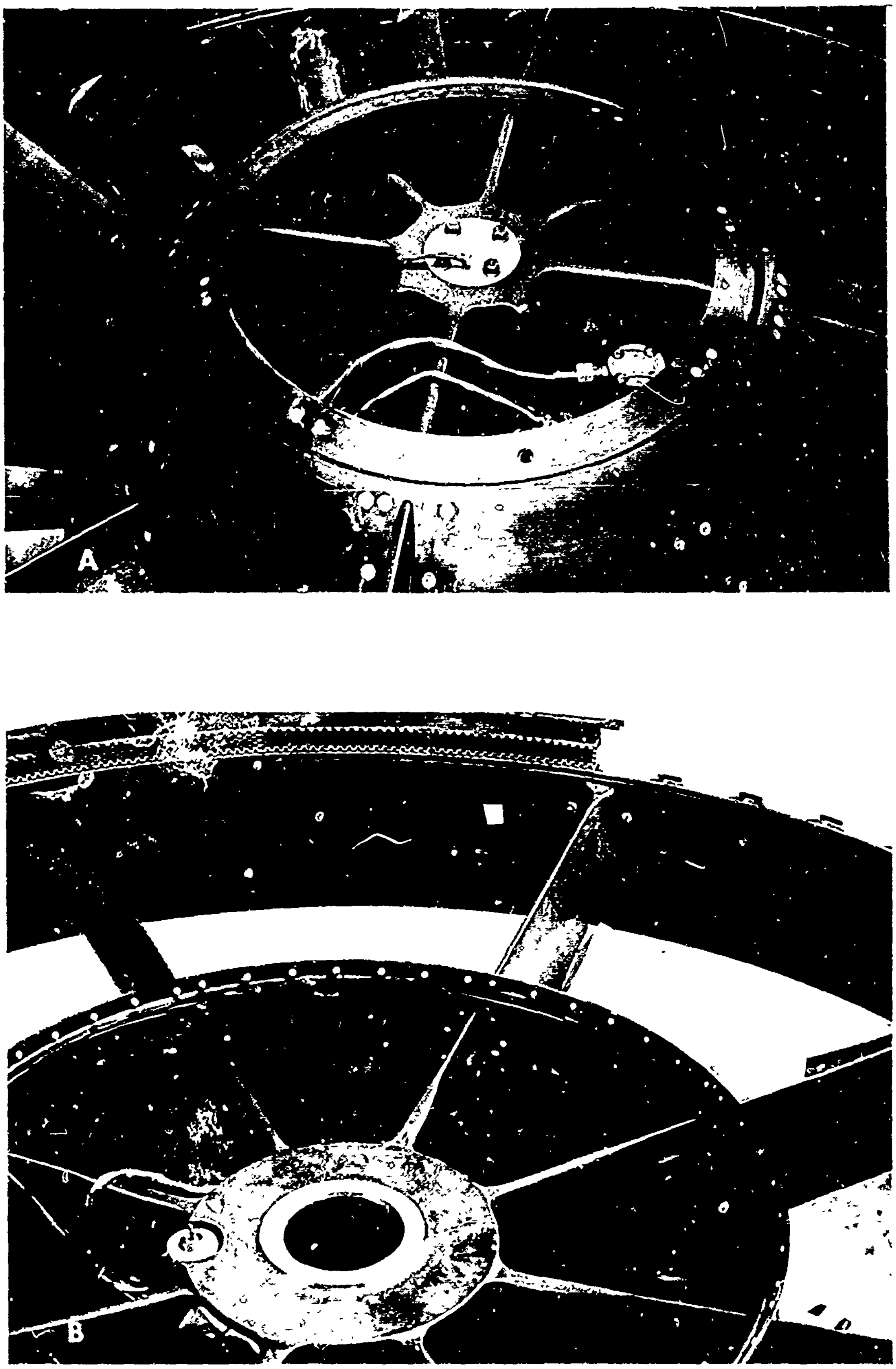


FIGURE 2.7 X376 PITCH FAN (A) VIEW OF FORWARD SIDE OF FRONT FRAME HUB, (B) VIEW OF AFT SIDE OF FRONT FRAME HUB

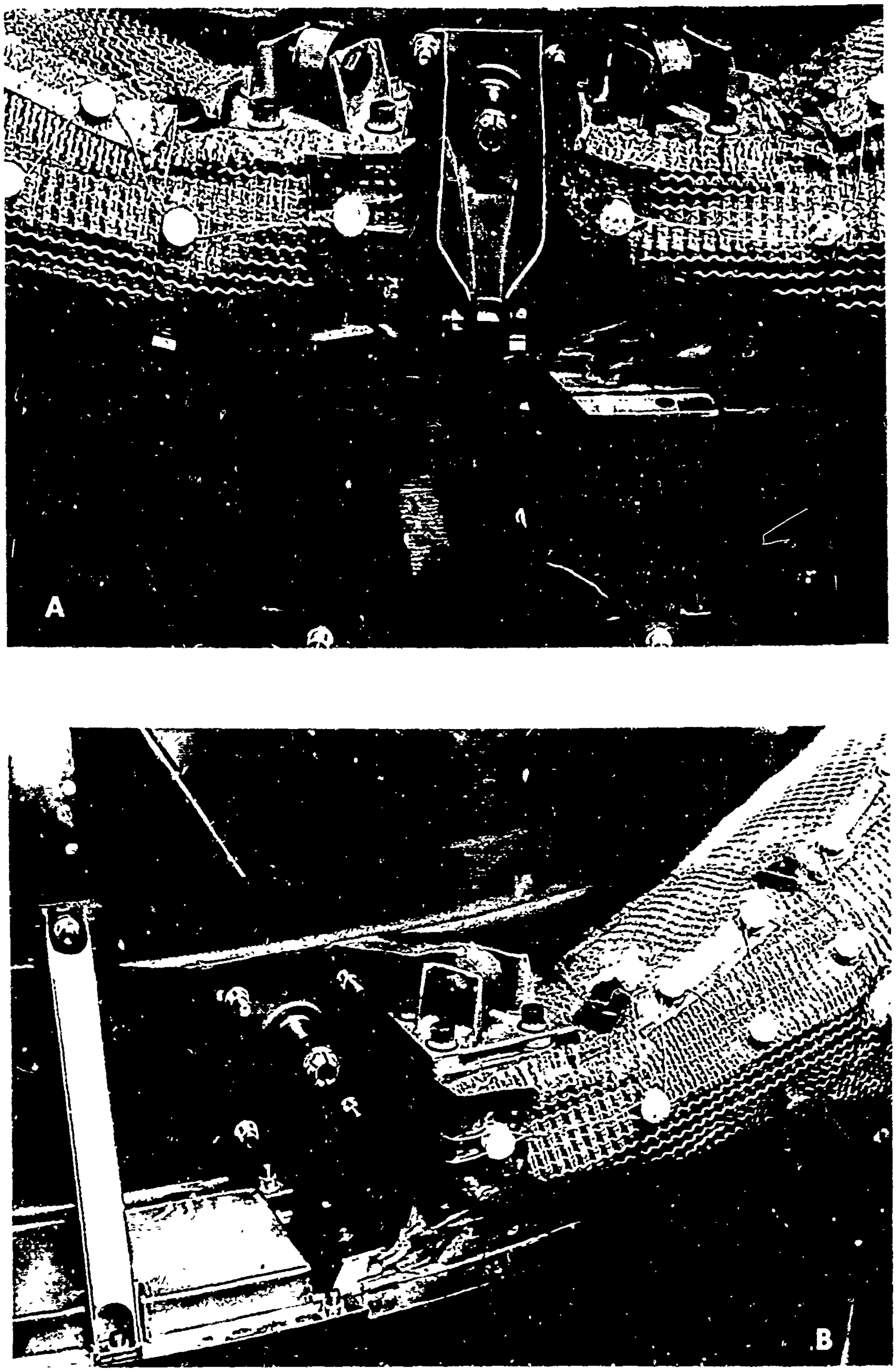


FIGURE 2.8 X376 PITCH FAN (A) FRONT-FRAME-TO-REAR-FRAME 6 O'CLOCK MOUNT, (B) FRONT-FRAME-TO-REAR-FRAME SUPPORT MEMBERS

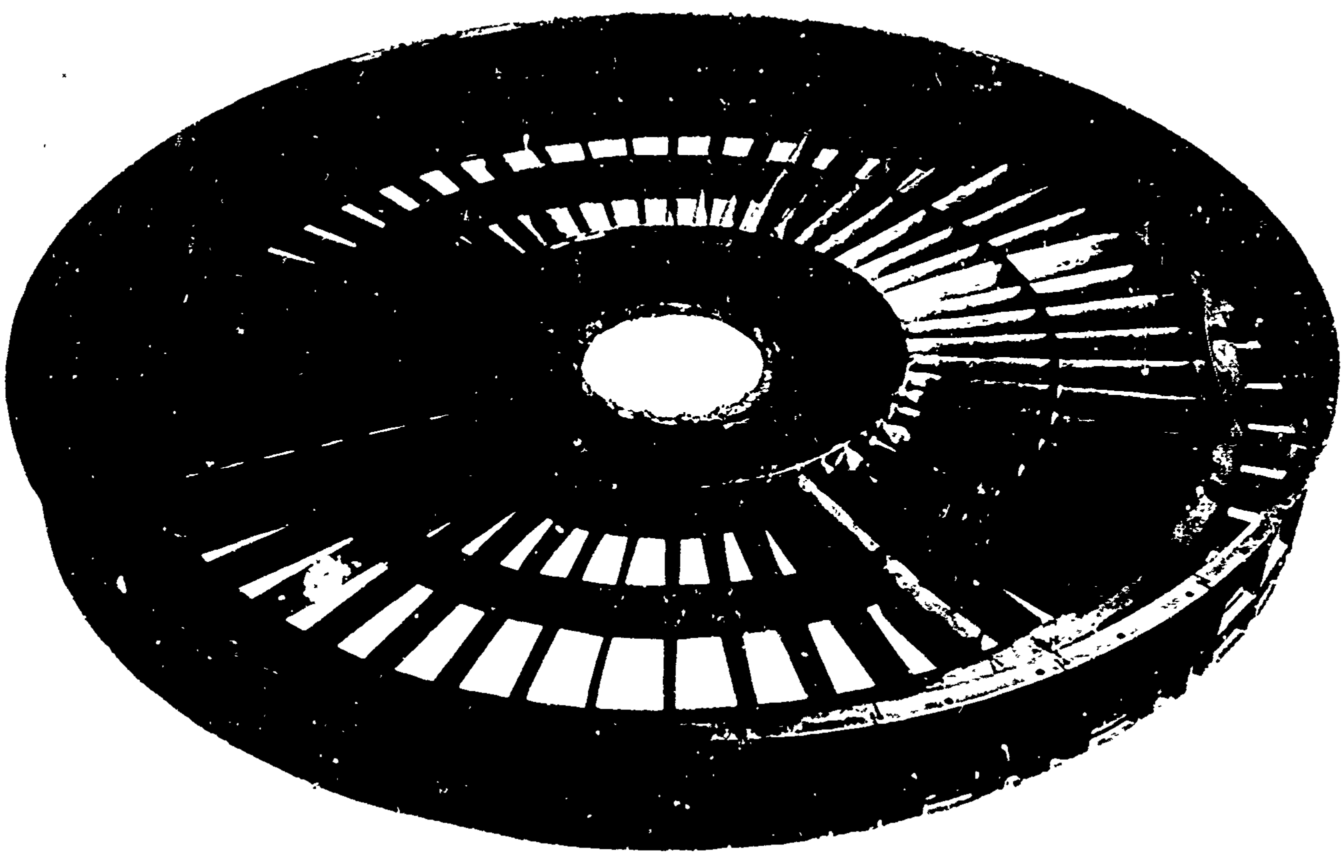


FIGURE 2.9 X376 PITCH FAN REAR FRAME

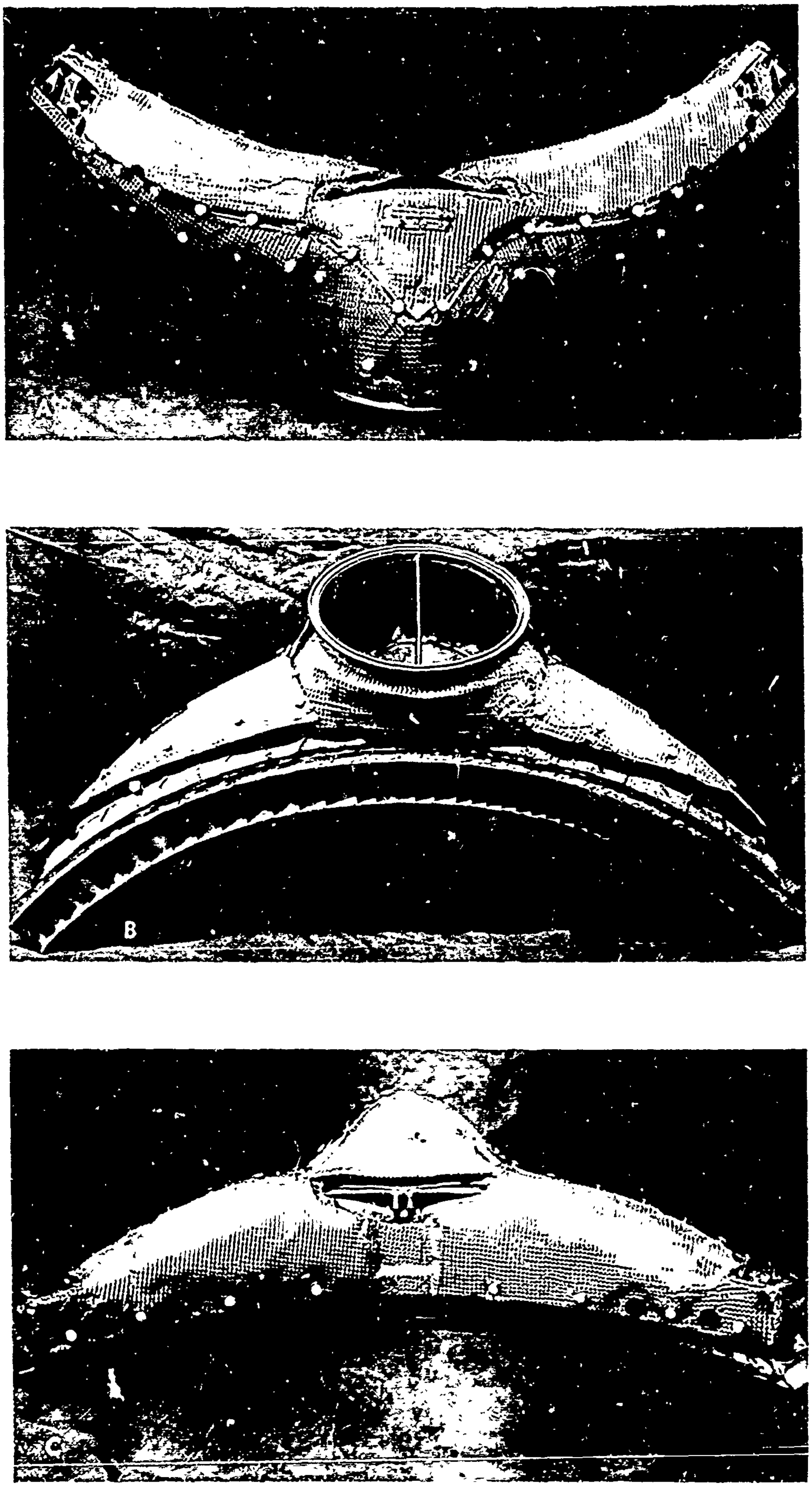


FIGURE 2.10 X376 PITCH FAN TURBINE INLET SCROLL

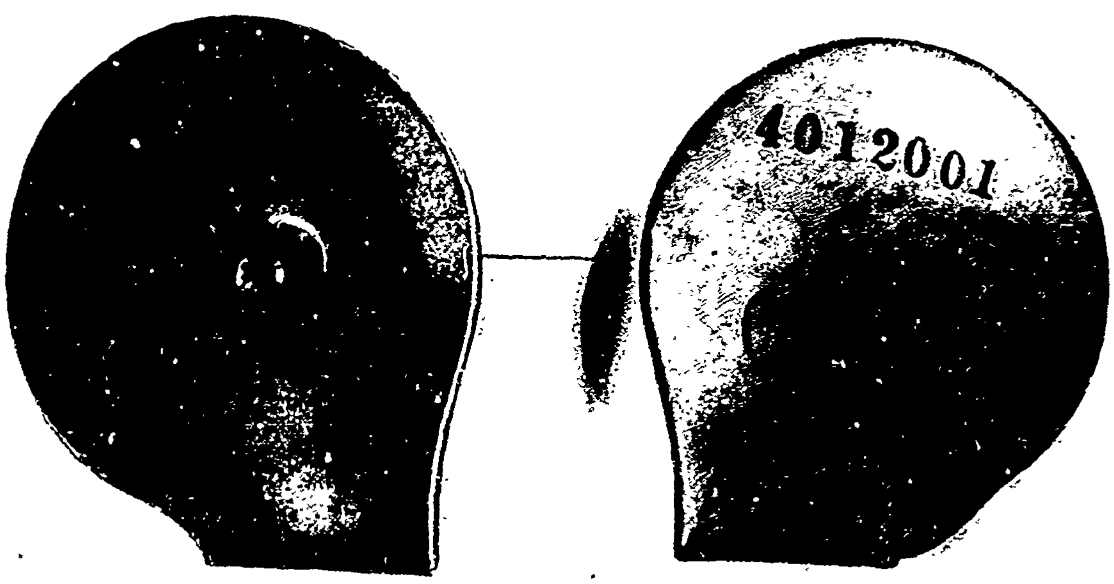


FIGURE 2.11 X376 PITCH FAN TURBINE INLET SCROLL (A) END MOUNTING PADS, (B) TURBINE AREA BLANK-OFF PLATES

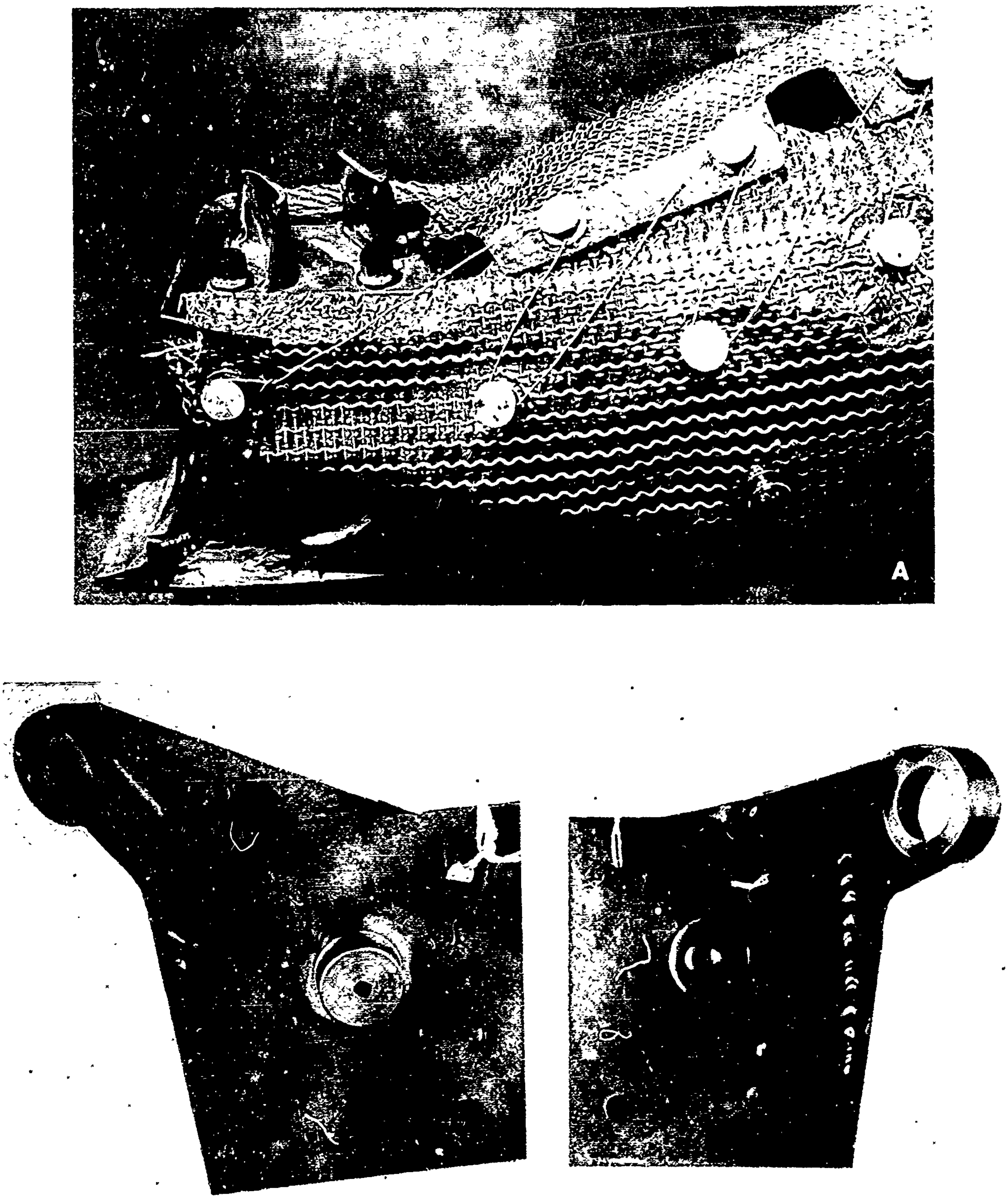
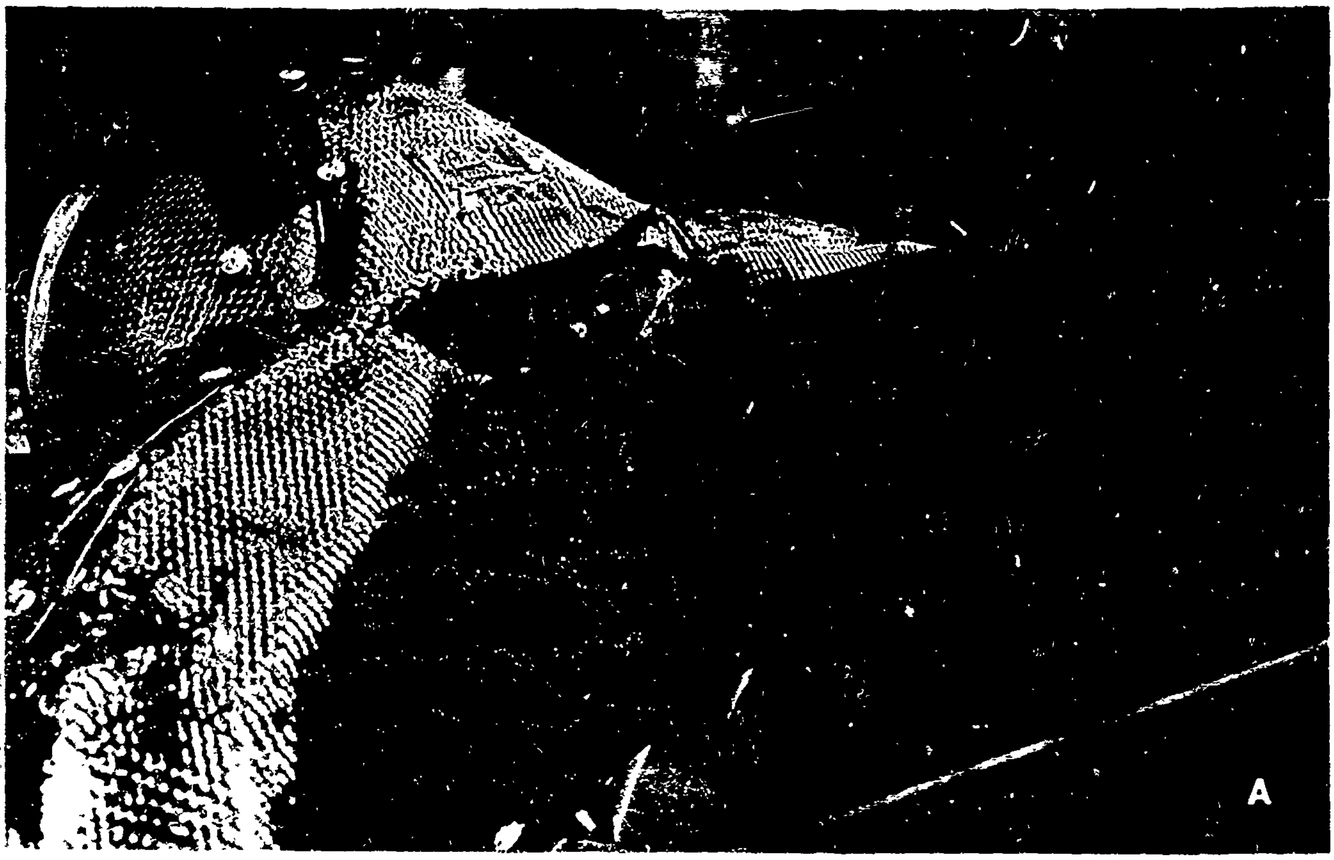


FIGURE 2.12 X376 PITCH FAN TURBINE INLET SCROLL (A) END MOUNT CLEVIS, (B) AND (C) SUPPORT ARM



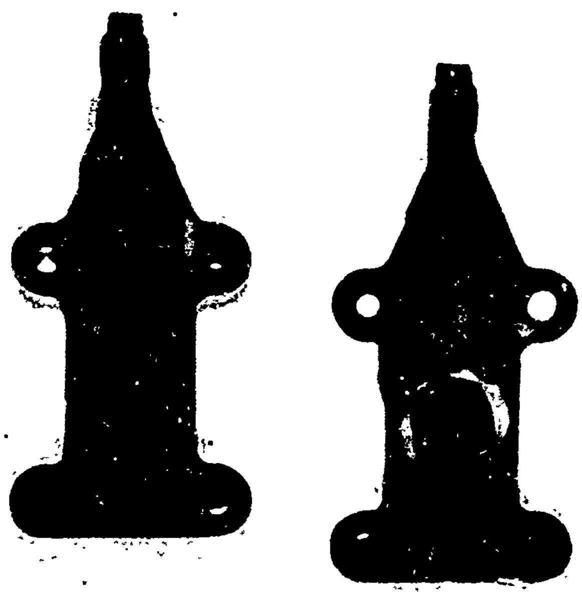
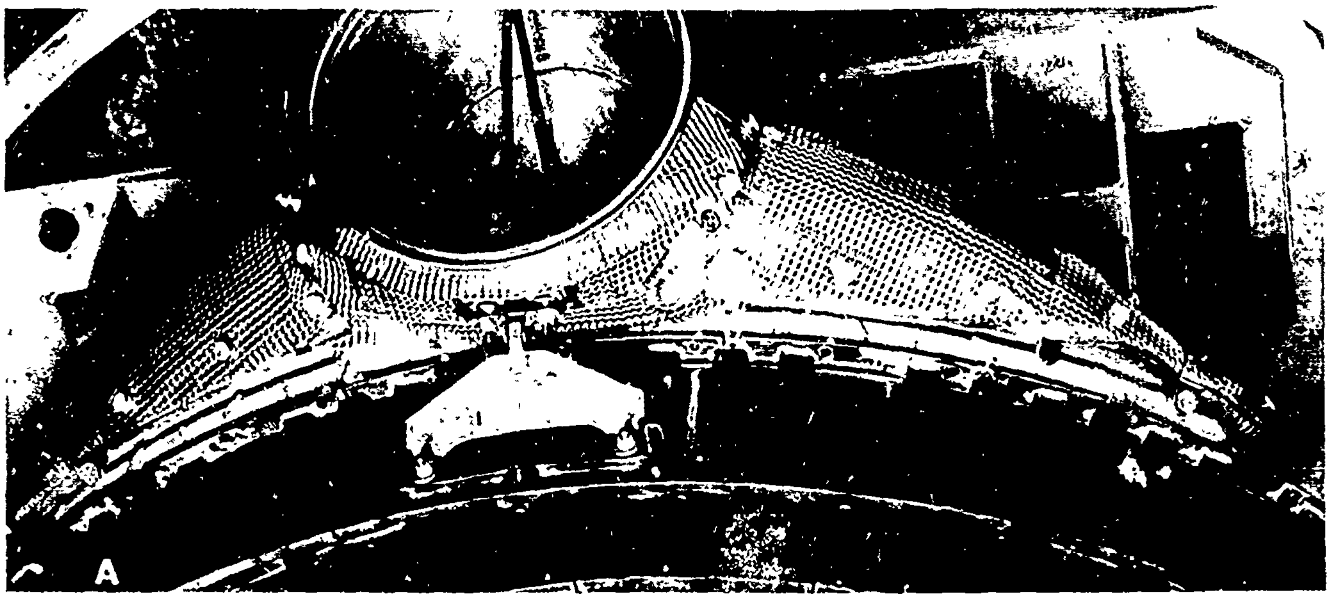


FIGURE 2.13 X376 PITCH FAN TURBINE INLET SCROLL (A) TOP CENTER MOUNT, (B) SUPPORT ARM



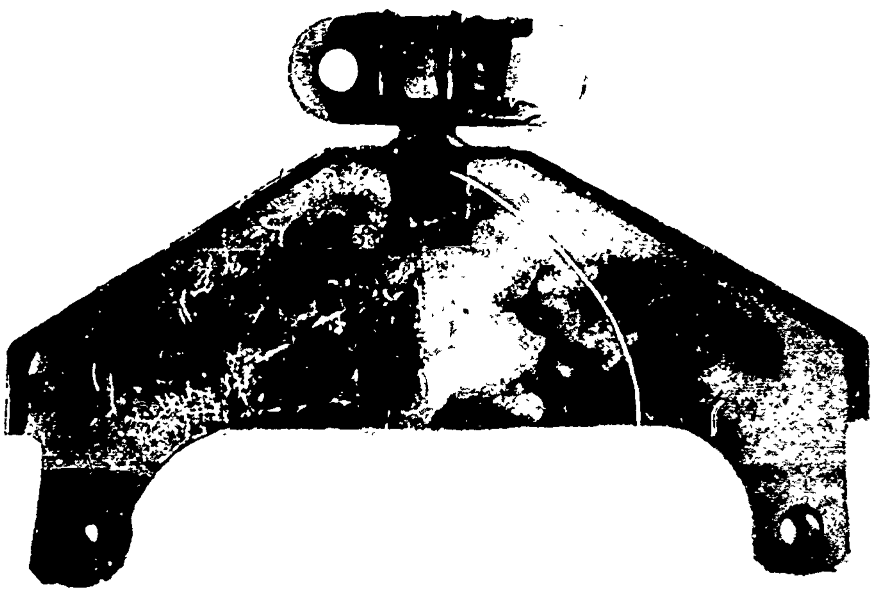


FIGURE 2.14 X376 PITCH FAN TURBINE INLET SCROLL (A) BOTTOM CENTER MOUNT, (B) SUPPORT ARM

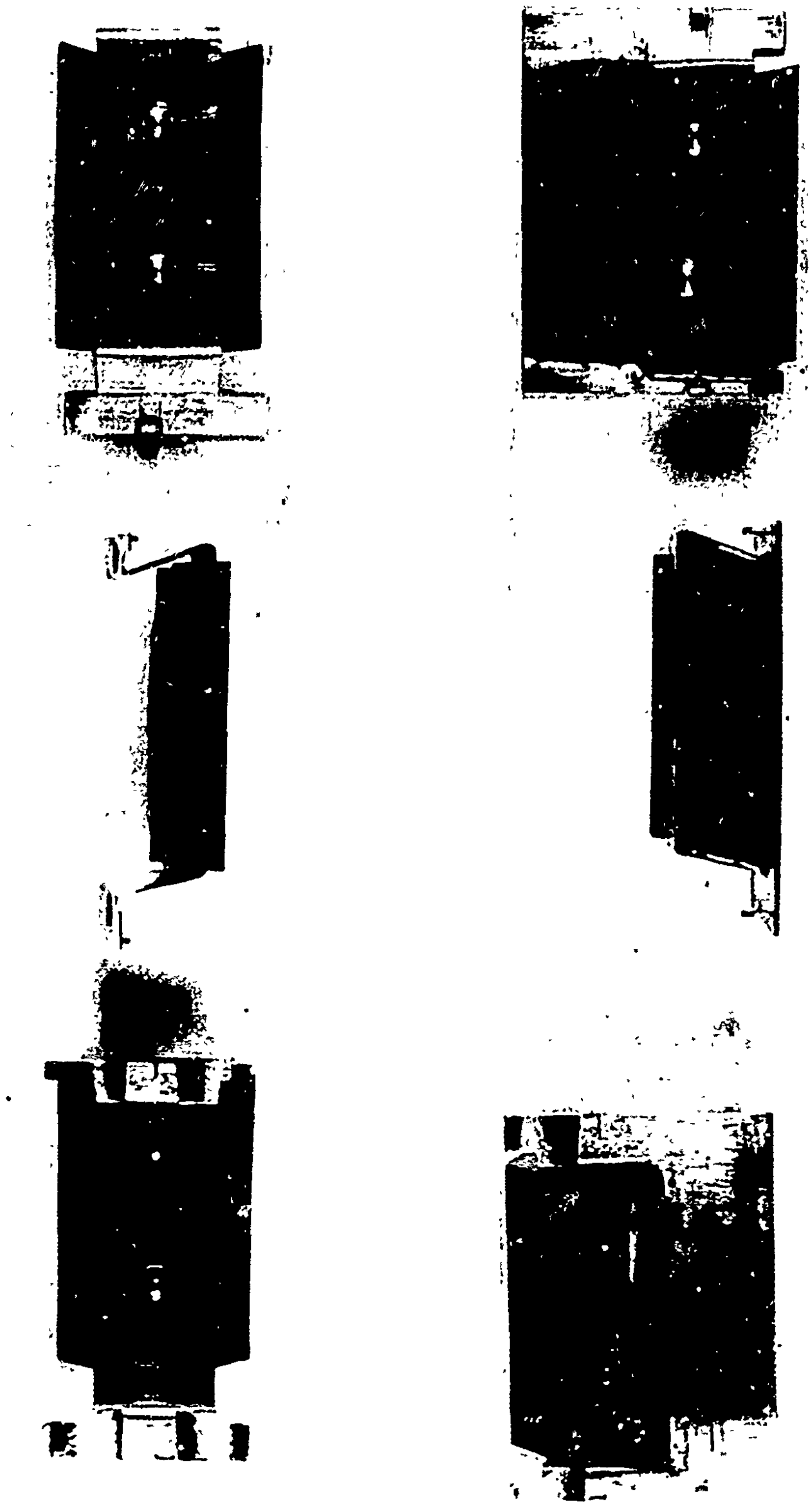


FIGURE 2.15 X376 PITCH FAN TURBINE INLET SCROLL (A) 6 O'CLOCK END SEAL, (B) 3 O'CLOCK AND 9 O'CLOCK END SEALS

SECTION 3.

SPECIAL TOOLS

3.1 GENERAL

a. This section lists, by function and numerical order, the special tools applicable to work prescribed in this manual. Reference to the tools in other sections of this manual are by the paragraph number indicated in the functional tool list.

b. Use plastic or rawhide (never metal) hammer heads when driving on any part of the fan. Never lift heavy parts by hand. Use a chain or powered hoist and special lifting yokes or straps. Apply pressure or tension evenly to all bearing pushers or pullers. Tighten jack screws and attaching screws, bolts and nuts in small increments (opposing point sequence).

c. The following paragraphs list the special tools. The paragraphs are arranged alphabetically according to part nomenclature and are subdivided on a functional basis. The numerical list of tools follows the functional list.

CAUTION

A safety load check should be performed on all lifting devices prior to use.

FUNCTION	TOOL	NUMBER	FIGURE
3.2 BEARING, OUTER RACE, BALL AND ROLLER			
REMOVAL:	Race Puller	4012028-611	3.4
3.3 BEARING, INNER RACE, BALL AND ROLLER			
REMOVAL:	Race Puller	4012028-610	3.3
3.4 FRONT FRAME			
ASSEMBLY:	Support Stand	4012028-789	3.11
	Shaft Line Up Pin	4012028-624	3.5
GRINDING:	Seal Grinding Fixture	4012028-670	3.8
INSPECTION:	Seal Inspection Fixture	4012028-678	3.9
TEARDOWN:	Support Stand	4012028-789	3.11
3.5 PITCH FAN			
SHIPPING:	Container	4012028-781	3.10
3.6 ROTOR			
ASSEMBLY:	Support Stand	4012028-664	3.6
BALANCE:	Arbor	4012028-559	3.1
	Balance Stand	4012028-667	3.7
INSPECTION:	Inspection Stand	4012028-667	3.7
TEARDOWN:	Support Stand	4012028-664	3.6
	Shaft Puller	4012028-609	3.2

3.7 NUMERICAL TOOL LIST

NUMBER	NAME	REFERENCE PARAGRAPH
4012028-599	Rotor Balance Arbor	3.6
4012028-609	Rotor Shaft Puller	3.6
4012028-610	Ball and Roller Bearing Inner Race Puller	3.3
4012028-611	Ball and Roller Bearing Outer Race Puller	3.2
4012028-624	Front Frame and Rotor Shaft Line Up Pin	3.4
4012028-664	Rotor Support Stand	3.6
4012028-667	Rotor Balance and Inspection Stand	3.6
4012028-670	Front Frame Air Seal Grinding Fixture	3.4
4012028-678	Front Frame Air Seal Inspection Fixture	3.4
4012028-781	Pitch Fan Shipping Container	3.5
4012028-789	Front Frame Support Stand	3.4

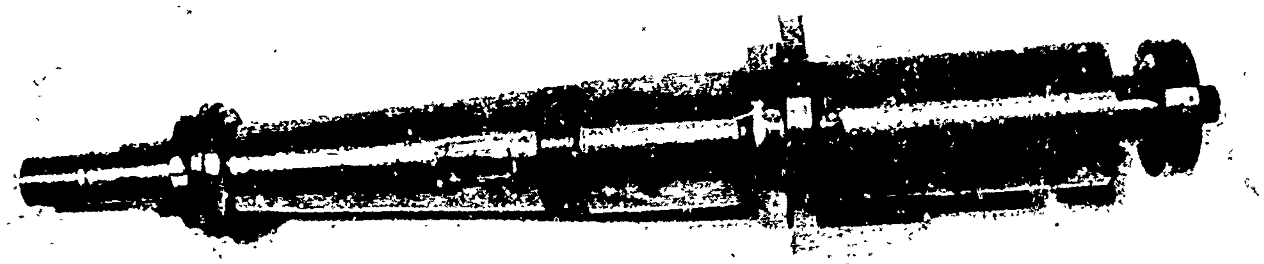


FIGURE 3.1 ROTOR BALA^CE ARBOR

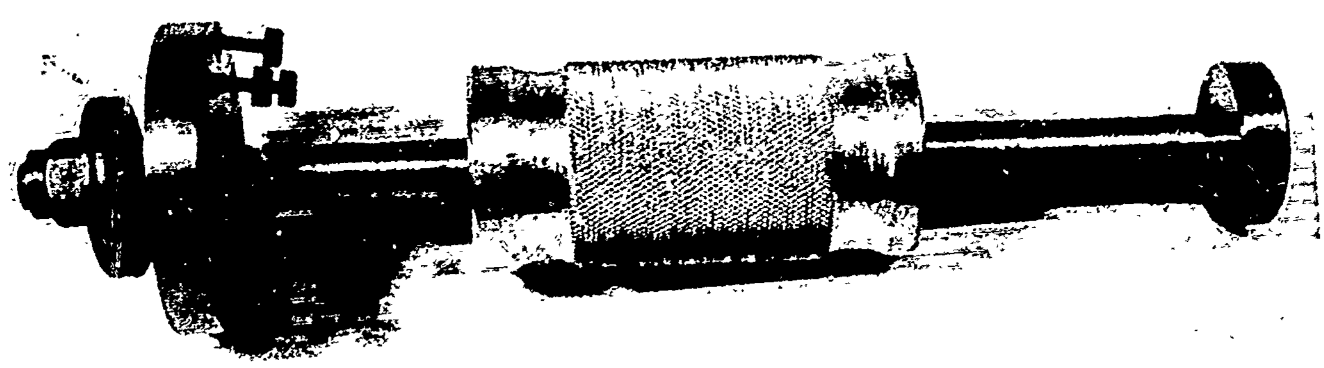


FIGURE 3.2 ROTOR SHAFT PULLER

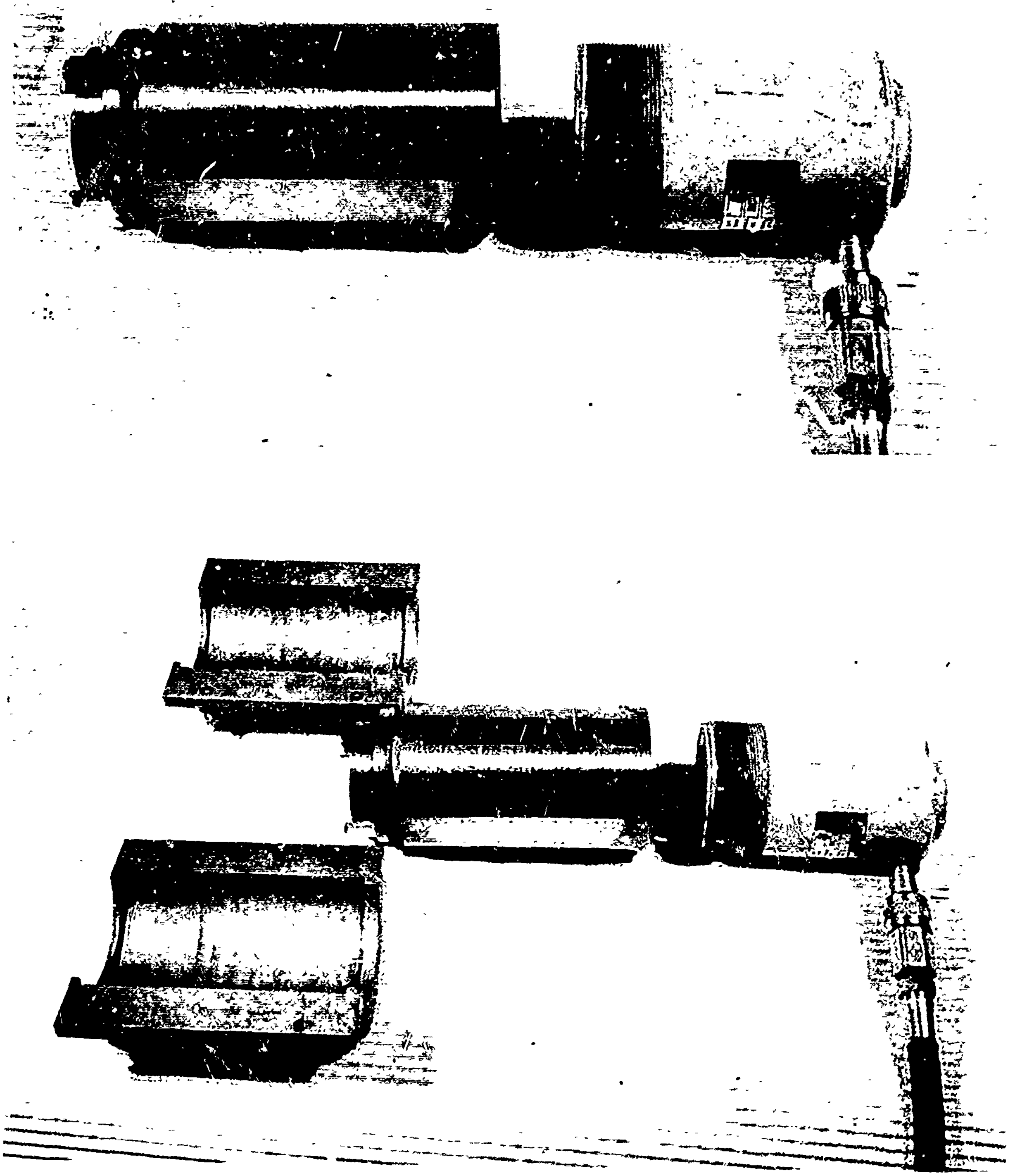


FIGURE 3.3 BALL BEARING INNER RACE PULLER (TOP); ROLLER BEARING INNER RACE PULLER (BOTTOM)

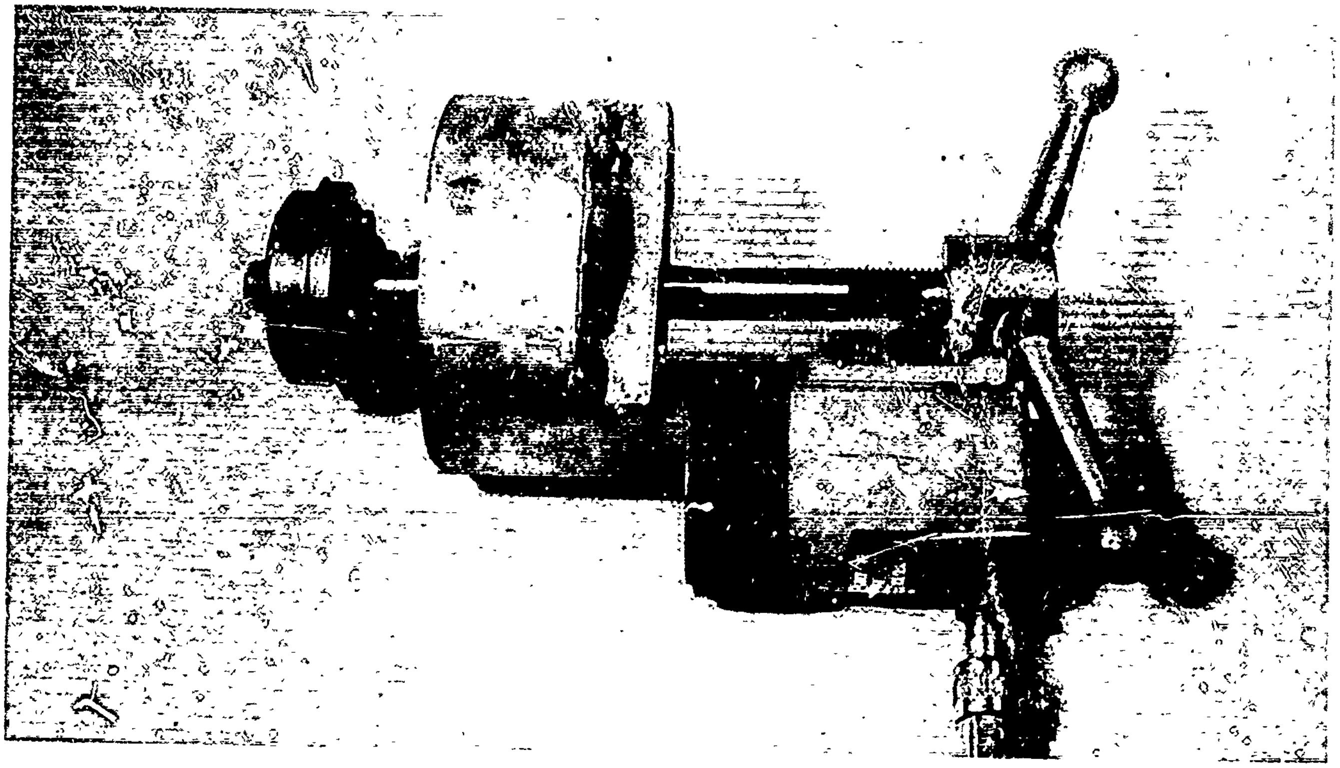


FIGURE 3.4 BALL AND ROLLER BEARING OUTER RACE PULLER

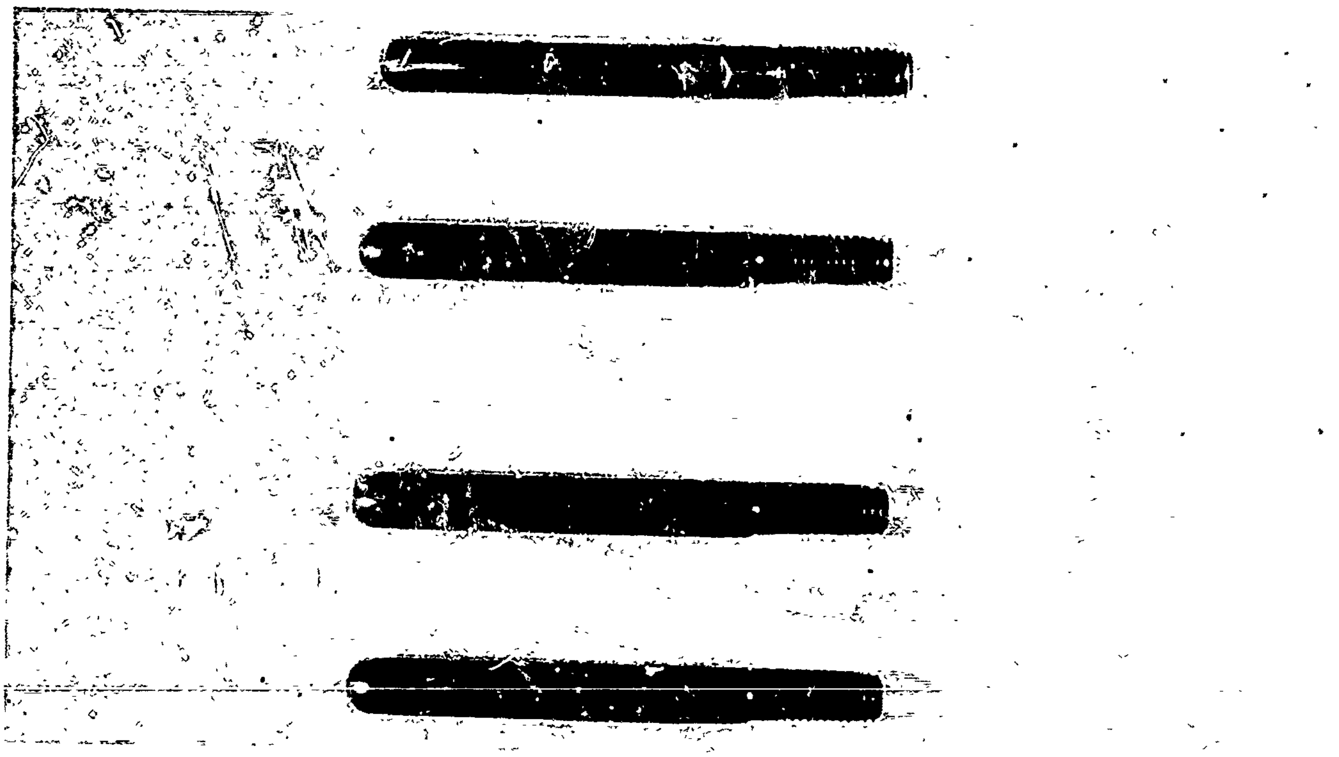


FIGURE 3.5 FRONT FRAME AND ROTOR SHAFT LINE UP PINS

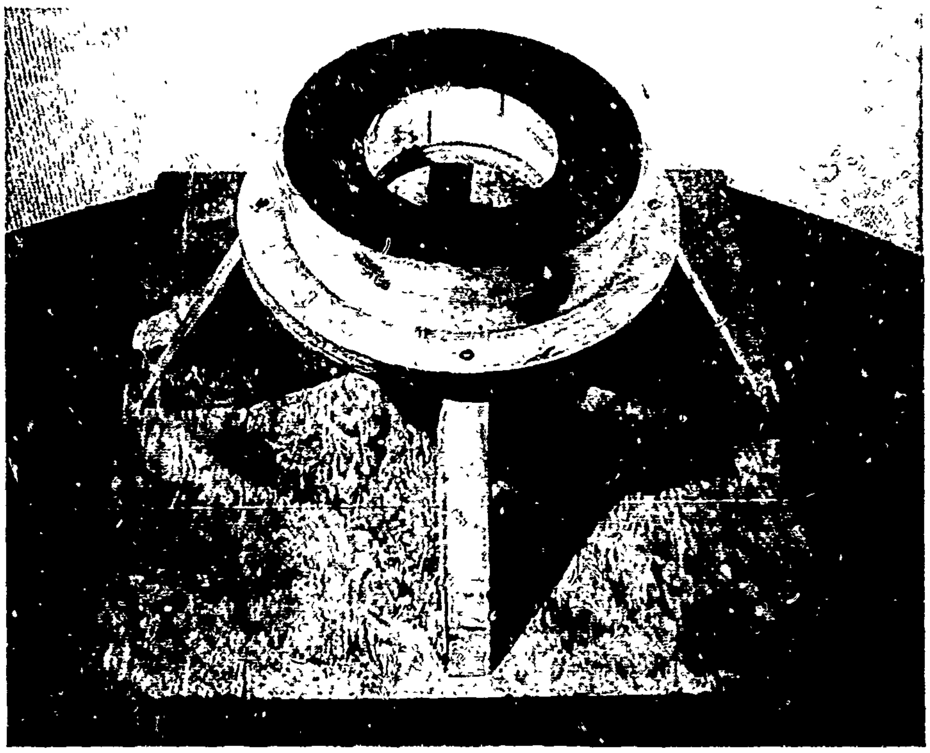


FIGURE 3.6 ROTOR SUPPORT STAND

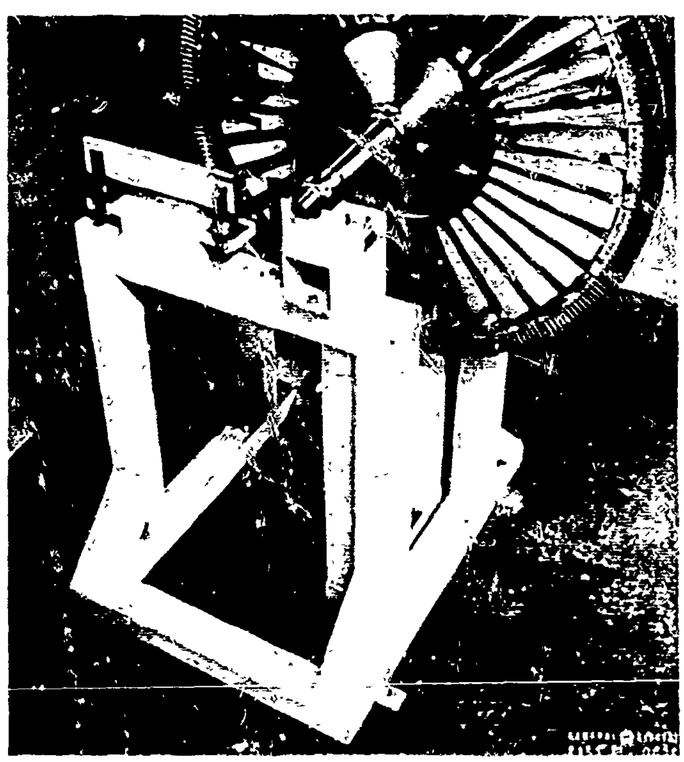


FIGURE 3.7 ROTOR BALANCE AND INSPECTION STAND

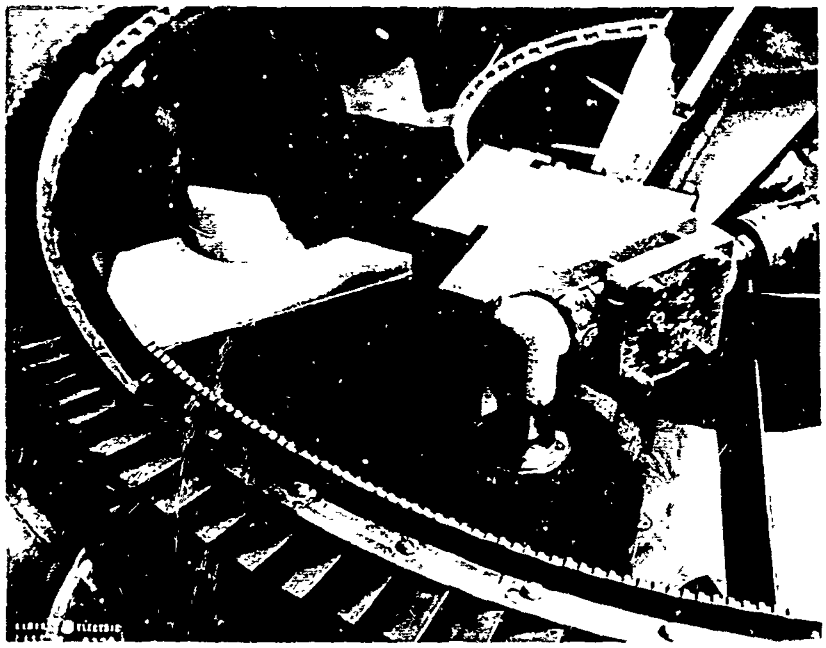


FIGURE 3.8 FRONT FRAME AIR SEAL GRINDING FIXTURE

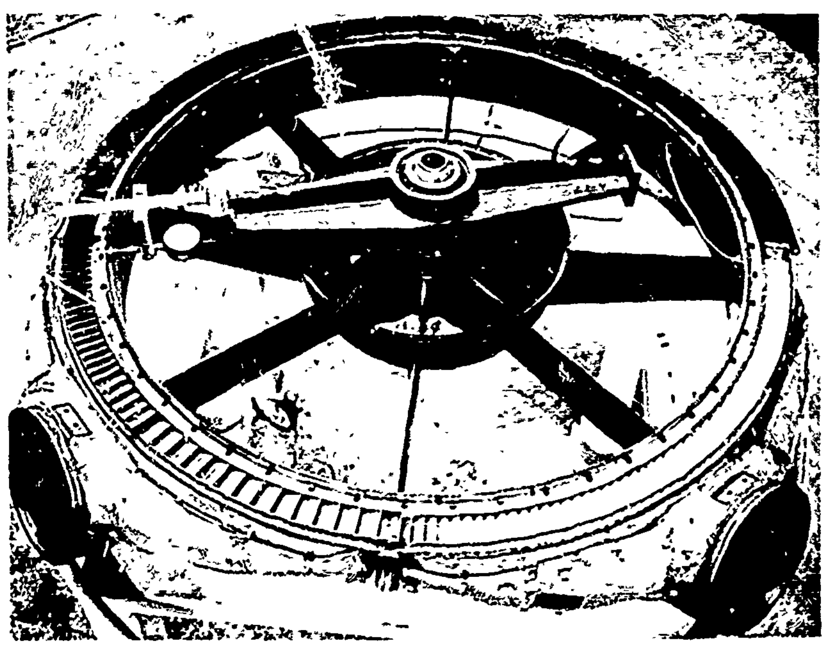


FIGURE 3.9 FRONT FRAME AIR SEAL INSPECTION FIXTURE

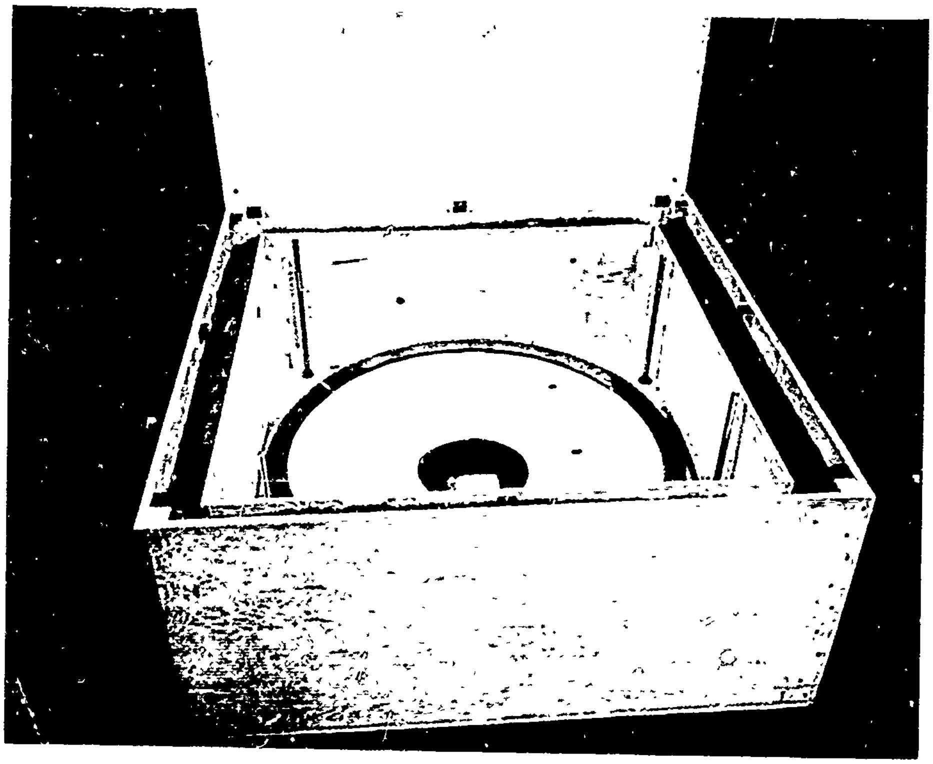


FIGURE 3.10 PITCH FAN SHIPPING CONTAINER

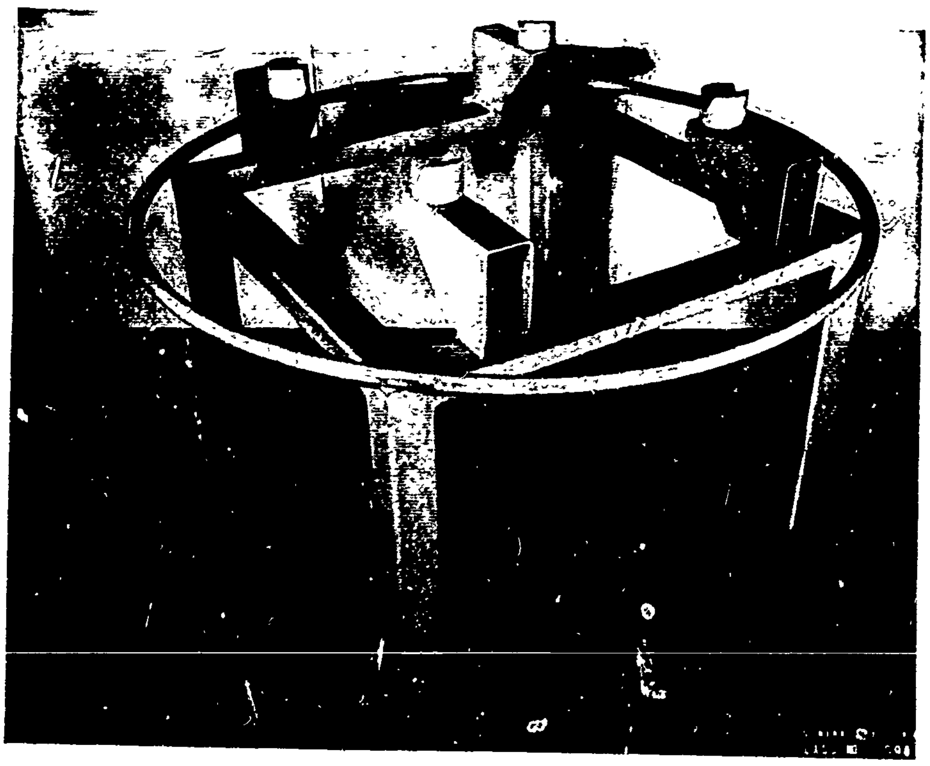


FIGURE 3.11 FRONT FRAME SUPPORT STAND

SECTION 4.

ASSEMBLY PROCEDURE

4.1 SCOPE

a. This section presents instructions for assembly of the individual parts into sub-assemblies; assembly of these into components; and final assembly of the X376 pitch control fan system (Figure 4.1). The procedure presents part names, sequence of assembly and the quantity of parts, but does not list the part numbers. The part numbers are listed on the Parts List which is included as an appendix to Section IV of this instruction.

b. This procedure provides instruction necessary for initial assembly of new parts. For normal overhaul and maintenance, paragraphs pertaining to original adjustment and fitting may be used for reference. Readjustment and refitting will be required when parts are replaced.

c. When starting an assembly sequence, read and observe all NOTE and CAUTION remarks for that sequence.

4.2 ASSEMBLY TOOLING

a. Where an assembly tool is required, the name of the tool will appear along with a reference to a paragraph in Section III, Tooling, which describes the procedure for use and installation of tools.

4.3 ROTOR ASSEMBLY

a. Orientation shall be as follows: viewing the rotor from the top looking down, place the zero point of the disc at the 12 o'clock position. The zero point will be indicated by part number and serial number stamped on the face of the outer circumference. The inlet or top face of the disc can be identified by nine small vent holes which are drilled through the outer face of the forward disc around the outer circumference. The #1 blade slot will be the first slot clockwise from the zero point. The #1 carrier will span blade positions #1 and #2. The weld joint on the torque band will be positioned between blade positions #36 and #1.

4.4 DISC ASSEMBLY

a. Set the disc on the Buildup Support Stand (Par. 3.6) with the forward face up and install the forward retainer ring with 36 wedge-shaped spacers and 36 nuts. Tighten the nuts sufficiently to hold the parts but allow enough play to shift the retainer circumferentially.

NOTE

The top and bottom ratainer rings are not interchangeable.

NOTE

The top surface of the wedge-shaped spacers must be perpendicular to the bolt centerline to assure proper seating of the nut.

b. Position the disc with the forward face down. Wrap a strip of masking tape around the circumference of the disc rim leaving about 1/2 inch of dovetail slot exposed at the top end (Figure 4.2).

NOTE

Masking tape will prevent the blade dovetail from seating against the blade retaining ring until all blades and the torque band are mated.

4.5 BLADE AND TORQUE BAND ASSEMBLY

a. Assemble six blades (equally spaced around the disc) into the slots and lower them against the masking tape. The convex side of the blades should face down. Assemble the torque band over the blade tip tangs making sure the weld on the torque band is between blade positions #1 and #36. Initally, the torque band can be assembled with either side up. However, upon disassembly, the position should be marked (forward and aft with Dykem) to insure that it will be reassembled in the same position. Slide the remaining blades into position in the torque band and dovetail slots.

NOTE

The blades are position-marked prior to assembly; refer to Parts List and Buildup Record for Serial numbers and correct position (per Balance Calculation, Pg. 4.8).

b. After all blades are assembled, remove the masking tape from the disc and gently work all blades into their respective slots.

c. Tighten the disc rim nuts sufficiently to hold the forward retainer ring.

CAUTION

When tightening the disc rim nuts, avoid using force great enough to pull the rim bolt through the hole.

d. Assemble the aft retainer ring with 36 wedge-shaped spacers and 36 nuts (Figure 4.2). Tighten but do not torque the nuts at this time.

NOTE

The top surface of the wedge-shaped spacers must be perpendicular with the bolt centerline to insure proper seating of the nut.

4.6 CARRIER ASSEMBLY

a. Slide the carrier for position #1 over the blade tangs at positions #1 and #2 and insert the center torque band bolt. This will position the torque band with the carrier. Insert the blade-carrier bolts from the forward side of the carrier and place the nuts on the aft side. Tighten the bolts but do not torque. These bolts are a select fit to obtain the largest size which can be freely installed.

NOTE

Refer to the Parts List and Build-up Record for the position and serial number of the carrier assemblies.

b. Assemble the remaining carrier assemblies in the following sequence: position numbers 10, 5, 15, 3, 7, 13, 17, 2, 11, 8, 16, 4, 12, 6, 14, 18, and 9.

c. Assemble the end torque band bolts.

d. Torque the blade/carrier bolts to 75 lb. in.

e. Torque the carrier/torque band bolts per Figure 4.3.

4.7 ROTOR INSPECTION

a. Assemble the balance and inspection arbor (Par. 3.6) and place the rotor in the inspection stand (Par. 3.6) per Figure 4.4.

b. Measure and record on Figure 4.4 the full indicator reading (FIR) of:

1. Rotating air seal O.D. (Figure 4.4, Dimension A).
2. Tip turbine shroud (forward side) O.D. (Figure 4.4, Dimension B).

c. Measure and record (on Figure 4.4) the maximum running radius of: (Mark high spots with Dykem).

1. Rotating air seal O.D. (Figure 4.4, Dimension C).
2. Tip turbine shroud (forward side) O.D. (Figure 4.4, Dimension D).

4.8 ROTOR BALANCING

List the rotor blades in a column in order of decreasing moment weights. Divide the list into pairs and determine the difference in moment weights of the blades in each pair; ie., 1 and 2, 3 and 4, 35 and 36. List these differences in an adjoining column. Lay out the blades on a balance plot (Figure 4.0) by placing the blades of a pair opposite each other beginning with blades 1 and 2 in blade positions 1 and 19; and alternately selecting pairs of blades from the top and bottom of the list; ie., blades 36 and 35 in blade positings 2 and 20. The blade plot should be filled out in this manner. Differences in blade moment weights should be determined for opposite carriage position. A judicious relocation of blades may have to be made to minimize these differences. Any relocation of blades should be made by pairs. Instrumented blades should be placed at least 90° apart.

Carriers and seals should be listed as described above for the blades. The balance plot for the carriers should be made as described for the blades. Differences in blade moment weights for opposite carrier positions should be placed on the plot and a judicious relocation of carriers should be made so that pairs of carriers with a large difference in moment weights are placed so as to balance blades with a large difference in moment weights. This procedure should also be followed for the seals.

Place the rotor on the knife edge static balance stand (Par. 3.6) and add weights to balance the rotor to within one gram at the disc rim. In the remarks column of the Parts List and Build-up Record, record the amount of weight added to each blade position number. Weights can be added to both the forward and aft sides of the disc.

4.9 TORQUE PROCEDURE -- RIM BOLTS

a. Tooling Requirements

1. Two torque wrenches equipped with 3/8" sockets.
2. One 2-to-3 inch O.D. micrometer having increments to 0.0001".

b. Procedure

1. Measure and record (on Figure 4.5) the length of each of the 36 rim bolts with all nuts loose.
2. Tighten both nuts on each bolt simultaneously to 90 lb. in. and measure and record the elongation of each bolt.
3. Increase the torque on each rim bolt in increments of 5 lb. in. until each rim bolt elongates 0.004 $\pm$ 0.0005 inches.

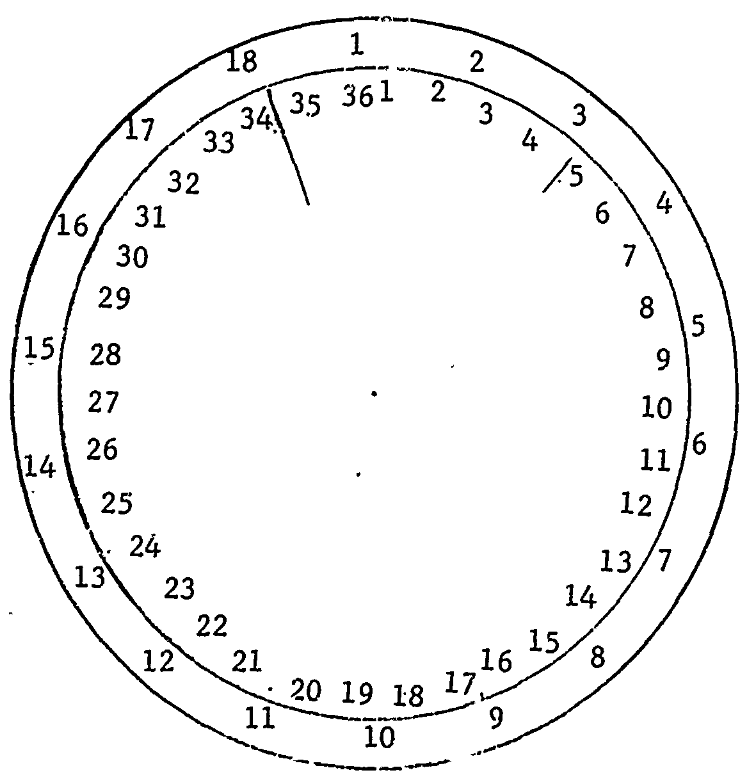


Figure 4.0

NOTE

If maximum permissible elongation is exceeded, loosen the nuts holding that bolt and repeat the above steps using a lower maximum torque value.

NOTE

The elastic properties of the rim bolts should cause the bolt to return to its original length when the torque is removed from the nuts. In the event the bolt does not return to its original length, it must be removed and replaced. Refer to Repair and Replacement of Parts, Section VII, for instructions on replacement of bolts.

CAUTION

When torquing the nuts to the rim bolts, apply simultaneous and equal pressure to both nuts to prevent shifting of the bolt through the hole.

c. The rotor component is now ready for final assembly.

4.10 FRONT FRAME ASSEMBLY

a. The front frame, scroll, and rear frame mounts are located and match drilled at initial assembly. The mounts may be removed and re-assembled, but all parts should be re-assembled in the same order and position. See Par. 4.12 for initial assembly instructions on adjustments and inspections.

b. All final assembly work on the pitch fan can be accomplished on the pitch fan build up stand (Par. 3.4). The principal components can be lifted in position by hand; however, the pitch fan lift and turnover sling (nylon) must be used to lift and turn the completely assembled pitch fan.

4.11 MOUNT ASSEMBLY

a. The method of attaching the aircraft mounts and the scroll mounts to the front frame is similar. The positions of the mounts are located and holes for body bound bolts are match drilled at initial assembly. Each of the three aircraft mounts are different parts and are not interchangeable; the two scroll center mounts are identical. After initial assembly, these parts can be removed and re-assembled without sacrificing alignment. However, the final assembly should be spot checked to assure proper alignment. If the scroll is replaced, the proper shim thickness must be redetermined.

b. All mounts are attached with four bolts. Two of these are body bound bolts which are located at the top right and lower left hand corners of each mount looking in from the outside.

NOTE

When removing the mounts, attach the shims to the mount. Upon re-assembly, make certain the shims are re-assembled with the mount.

c. Assemble the uniball and snapring to each of the four scroll support arms.

4.12 SCROLL TO FRONT FRAME ADJUSTMENTS

a. The scroll is located radially and axially with respect to the rotor centerline.

b. The scroll center mount will fix the scroll axial position; this mount has no axial adjustment.

c. Shims can be added under the center mount to adjust the radial location of the scroll nozzle diaphragm. See Par. 4.17 for radial and axial settings.

d. Shims should be added under the scroll end mounts to equalize the radial location of the scroll ends.

e. Shims should be added under the four scroll end clevices to obtain the same axial height that exists at the center of each scroll.

f. Both scrolls should be located circumferentially as close to each other as possible.

4.13 SCROLL SEALS TO FRONT FRAME ADJUSTMENTS

a. The fixed seals on the scroll will be trimmed after the scroll has been located on the front frame to obtain the proper overlap as shown in Figure 4.6.

b. The scroll seal ends must fit the scroll and front frame to permit the scroll to grow out from the center mount and move along the end mounting pins. The end seal is fixed such that the scroll will slide into the seal. The seal is free to move radially out from the rotor centerline. Minimum space for scroll growth to the end seal is shown in Figure 4.7.

4.14 MOUNT TO FRONT FRAME ADJUSTMENT

a. After the scroll is located and the shim thickness is determined, the mount holes must be reamed to accommodate body bound bolts. Ream the holes to 0.190 - 0.191" through the mount and the frame.

4.15 SCROLL SUPPORT ARM TO CLEVIS ADJUSTMENT

a. The scroll must be shifted radially to change the scroll-clevis-to-support-arm clearance. When setting the radial location of the scroll, the minimum clearance at the clevis mount must be observed and maintained.

4.16 SCROLL ASSEMBLY

a. Assemble the end clevis with four bolts and the required amount of shims.

b. Assemble the insulation blanket.

c. Install the two center rear frame supports using two bolts and the proper amount of shims.

d. Assemble nozzle blank-off caps as required.

4.17 INSPECTION - SCROLL TO FRONT FRAME

a. Assemble the scrolls to the front frame with the scroll seal ends and insert the two end pins and one center mount pin to each scroll.

b. Using fixtures referenced in Par. 3.4, measure and record the radius on each scroll from the rotor axis to the inside diameter of the inner scroll lip at the center of the scroll (Figure 4.8, Dim. A).

c. The radial distance between the rotor axis and the inside diameter of the inner scroll lip should be equal at the ends (Figure 4.8, Dim. A).

d. Measure and record the scroll seal overlap (Figure 4.6).

e. Measure and record the clevis spacing on the scroll support at the scroll ends (Figure 4.9).

4.18 COVER ASSEMBLY

a. Assemble the eight support brackets to the top of the front frame using eight bolts and nuts.

b. Lay the cover over the "cold" side of the rear frame and line up the support bracket with the inner flange holes. The bracket-to-cover bolts should be attached temporarily until the air seal segments are assembled.

c. Assemble spacers between scroll seal and front frame.

4.19 MAGNETIC SPEED PICKUP BUSHING ASSEMBLY

a. Insert the pickup bushing from the aft side of the frame and screw the cap to the top side of the bushing, tighten and lockwire. Slide the pickup into the bushing and determine the amount of shim required to locate the end of the pickup flush with the end of the bushing.

4.20 ASSEMBLE AIR SEAL SEGMENTS

a. The 26 air seal segments are match ground as a set and are position numbered. They should be re-assembled per position number starting with #1 at the 12 o'clock position and proceeding in a clockwise direction looking down (aft).

b. Place the honecomb seal segments over the scroll seal with the center hole over the center hole in the scroll seal segment. Start the 52 bolts and torque to 30 lb. in.

4.21 AIR SEAL GRINDING INSTRUCTION

a. Grind the seal face (inside diameter) using fixtures referenced in Par. 3.4).

b. To determine the final radial dimension of the air seal, add the radial clearance desired (Par. 4.28) to the rotor air seal lip radius (Par. 4.7.c.1).

4.22 AIR SEAL RADIAL INSPECTION

a. Measure and record the air seal minimum radius using fixtures per Par. 3.4 and instructions in Figure 4.10.

4.23 DISC BEARING ASSEMBLY

a. Lay the rotor on a pallet with the forward face up and insert the grease shield into the housing and seat it against the shoulder. The lip of the seal should point up.

b. Using dry ice and alcohol, freeze the outer race of the thrust (ball) bearing and insert it into the bearing housing. Place the balls and cage into the outer race and insert the top grease shield with the lip facing up.

c. Place the rotor in a position with the aft face up and insert the top grease shield.

d. Using dry ice and alcohol, freeze the outer race and rollers and insert them into the housing with the puller lip facing the assembler. Install the grease seal and retainer and secure with eight bolts and nuts. Torque to 30 lb. in.

e. Pack both bearings with MIL-G 3278 lubricant: 1) 10 grams in the ball bearing; 2) 10 grams in the roller bearing.

4.24 SHAFT BEARING ASSEMBLY

a. Heat the roller bearing inner race (250°F maximum) and slide it over the shaft.

b. Slide the spacer (with the large diameter facing aft) over the shaft and seat it against the inner race.

c. Heat the bottom half of the ball bearing inner race (250°F maximum) and lower it over the shaft with the square end facing aft.

4.25 SHAFT TO DISC ASSEMBLY

a. Slide the shaft carefully into the bearing from the aft side until the thrust bearing inner race seats against the balls.

b. Heat the top half of the thrust bearing inner race (250°F maximum) and slide it over the shaft and seat it against the bottom half of the inner race.

c. Place the retainer over the flange; sandwich the speed generator disc between the retainer and the flange. Use eight bolts and nuts. Torque to 30 lb. in.

CAUTION

The bolt heads on the forward end of the shaft are shorter than those on the aft end. The rotor will interfere with the front frame it the wrong bolts are used on the forward face.

d. When the races have cooled, measure and record on Figure 4.11 the axial travel of the bearing to insure that the thrust bearing inner races have seated. Maximum allowable travel is 0.040".

e. Set up a dial indicator from the end of the shaft and measure F.I.R. of the speed generator face (Record on Figure 4.11). Maximum allowable runout - 0.005 in.

4.26 ROTOR TO FRONT FRAME AND SCROLL ASSEMBLY

a. Install line up pins (Par. 3.4) in the forward end of the rotor shaft.

b. Heat the front frame area with heat lamp(s) for one-half hour.

c. Lower the front frame over the shaft and line up with the pins in the rotor shaft. Lower the frame until the shaft seats.

d. Remove the line up pins from the shaft. Assemble the cover plate to the forward face of the front frame hub and insert four bolts through the cover plate, front frame, and into the shank nuts located on the inside of the rotor shaft. Torque to 30 in. lbs. and lockwire.

4.27 ROTOR ADJUSTMENTS

a. Shims are located between the thrust bearing inner race top face and the shoulder on the hub of the front frame. Add or remove shims to locate the forward air seal lip flush with the bottom edge of the honeycomb air seal with the pitch fan located in its flight attitude.

4.28 ROTOR SEAL CLEARANCE INSPECTION

a. A minimum gap of 0.036" should be maintained as running clearance between the rotor air seal lip and the honeycomb seal. At final buildup of the rotor, measure the maximum radius of the air seal lip on the rotor per Par. 4.7.b.1. Mark the location of the maximum radius with Dykem.

b. The honeycomb air seals are ground to a diameter which is based on the dimension obtained in the above rotor inspection plus the amount of radial gap required (0.036" required). After the honeycomb air seals are ground, their radius is measured and recorded on Figure 10 (Par. 4.22a), and the location of the minimum radius is marked with Dykem. When the rotor is seated in the front frame, align the Dykem mark on the rotor seal lip with that on the honeycomb seal and measure the minimum gap with feeler stock; record the dimension of the gap on Figure 10, Dimension "B".

4.29 REAR FRAME TO FRONT FRAME AND SCROLL ASSEMBLY

a. Place the front frame on the dolly (Par. 3.4) with the forward side down.

b. Slide the outer scroll seal segments under the lips on the scroll. The seal segments should be position-marked and should be assembled starting with #1 at the 12 o'clock position looking down and working in a clockwise direction.

c. Lower the rear frame over the rotor and line up the flanges. Secure with bolts and nuts on the cold side of the flange. Insert the bolts through the flange and scroll seal segments, install nuts and torque to 35 lb. in.

4.30 REAR FRAME TO FRONT FRAME CONCENTRICITY INSPECTION

a. The rear frame to front frame concentricity must be checked prior to final assembly to assure sufficient running clearance between the rotor tip and the rear frame. However, the clearance between the rotor tip and rear frame can be checked only at the 6 o'clock position. Since the minimum clearance may occur at a location other than 6 o'clock, the following method must be used to establish a reference for computing rotor tip running clearance (minimum clearance 0.095").

1. Assemble the rear frame to the front frame and install the rear frame inspection arbor (Par. 3.4).
2. Sweep the inside diameter of the rear frame bucket channel and determine and record the minimum radius.
3. Measure and record the radius at the 6 o'clock position.
4. Subtract to obtain the difference. The dimension thus obtained will serve as a reference for computing rotor tip running clearance (Par. 4.33.a.)

4.31 INSULATION BLANKET ASSEMBLY

a. Wrap the external insulation blanket segments around the rear frame and lockwire them in place.

b. Install the three rear frame hangers (1 each at the center of the scrolls and 1 at the adjacent arm of the two scrolls) using two bolts to each. Insert the bolts in the hanger-to-mount holes; install the nuts and torque to 45 to 50 lb. in.

NOTE

Insert shims between the hangers and scroll center mounts as required.

4.32 INSPECTION -- ROTOR TURBINE SHROUD TO REAR FRAME

a. Measure the radial distance between the highest radius point on the rotor and the rear frame at the 6 o'clock position. Subtract from this dimension the dimension obtained in Par. 4.31.a.4 to obtain the running clearance between the rotor tip and rear frame bucket channel.

4.33 SPEED PICKUP ASSEMBLY

a. Slide the pre-determined amount of spacers (Par. 4.19) over the speed pickup and slide the pickup into the bushing and screw on the cap. Tighten and lockwire them in position.

b. Hook up the amphenol connector and fasten with lockwire.

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
1	4012001-940G1	Assembly - Pitch Fan	X
2	4012001-177G1	Disc Assembly	1
	LH3983-02	Nut	6
	MS9033-05	Bolt	6
3	4012001-175P1	Blade	36
4	4012001-173G2	Bucket Carrier	18
	4012001-172P1	Bucket Shell	252
	MT2C832	Anchor Nut	18
	MT11C832	Anchor Nut	36
	AN123619	Rivet	72
5	4012001-184P1-P5	Bolt	36
6	(LH)3417-048	Nut	36
7	4012001-174G1	Torque Ring	1
8	4012001-185P1	Bolt	54
9	4012001-186P1	Retainer Ring	1
10	4012001-187P1	Retainer Ring	1
11	4012001-188P1	Spacer	AR
12	LH3983-048	Nut	72
13	4012001-334P2	Seal	1
14	4012001-305P2	Bearing - Ball	1
15	4012001-320P2	Seal	1
16	4012001-355P1	Retainer	1
17	4012001-357P2	Bolt	76
18	LH3858-02	Nut	155

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
19	4012001-339P1	Spacer	1
20	4012001-336G1	Shield	1
21	4012001-304P2	Bearing - Roller	1
22	4012001-335P2	Seal	1
23	4012001-354P1	Retainer	1
24	4012001-361P1	Disc - Speed	1
25	4012001-303G3	Front Frame	1
	MS20470DD4-16	Rivet	16
	MS20470DD4-12	Rivet	12
	52LHTA521M-02	Anchor Nut	8
	AN5071032-7	Screw - Flat Head	8
	AN426DD3-3	Rivet	16
	AN426DD5-7	Rivet	48
	AN426DD4-6	Rivet	208
	AN340	Nut #6 (.138) 32 NC	4
26	AN507C1032-8	Screw - Flat Head	8
27	4012001-321G1	Cover	1
28	4012001-349G1	Seal	26
29	4012001-357P1	Bolt	27
30	4012001-338G2	Shaft	1
	ZL2669-5-02	Shank Nut	8
	ZL2669-10-02	Shank Nut	4
31	4012001-373G1	Mount - Center	1
32	4012001-373G2	Mount - Left Hand	1

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
33	4012001-373G3	Mount - Right Hand	1
34	4012001-329G1	Mount - Center	1
35	4012001-353G3	Mount - Inlet	2
36	4012001-356P3	Bolt	2
37	4012001-356P4	Bolt	8
38	LHSS4	Uniball Bearing	4
39	N5000-68	Snap Ring	4
40	4012001-502P2	Bolt	8
41	4012001-502P3	Bolt	2
42	4012001-359P1 & P2	Shim	AR
43	4012001-360P1 & P2	Shim	AR
44	4012001-372P1	Spacer	AR
45	4012001-344P1	Plate	1
46	4012001-357P8	Bolt	4
47	4012001-502P4	Bolt	6
48	4012001-341P1 & P2	Spacer	AR
49	4012001-366P1	Nut	1
50	4012001-365G1	Bushing	1
51	MS9200-07	Nut	1
52	4012001-455G3	Scroll	2
	4012001-466P1	Nozzle Partition	28
	4012001-467P1	Nozzle Partition	10
	4012001-467P2	Nozzle Partition	50
	4012001-465P1	Strut	20

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
52	4012001-464	Scroll Contour	
53	4012001-475G1	Clevis	2
54	4012001-476G1	Clevis	2
55	R112P2S	Bolt	20
56	4012001-482P1	Bolt	4
57	4012001-481P1-P3	Shim	AR
58	4012001-482P4	Bolt	2
59	4012001-491G1	End Cover	1
	AN123152	Rivet	2
60	4012001-492G1	End Cover	1
	AN123152	Rivet	2
61	4012001-493G1	End Cover	1
	AN123152	Rivet	2
62	4012001-494G1	Cap - Blank Off	2
63	4012001-494G2	Cap - Blank Off	2
64	4012001-495G1	Cap - Blank Off	2
65	4012001-495G2	Cap - Blank Off	2
66	AN900-4	Gasket	24
67	AN900-3	Gasket	6
68	MS9033-12	Bolt	6
69	4012001-501P1	Bolt	24
70	4012001-483P2	Seal	1
71	4012001-484P1	Seal	6
72	4012001-485P1	Seal	1

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
73	4012001-486P1	Seal	1
74	4012001-487P3	Seal	1
75	4012001-488P1	Seal	1
76	4012001-489P1	Seal	1
77	4012001-490P2	Seal	1
78	4012001-605G4	Rear Frame	1
	4012001-611G4	Compressor Vane	14
	4012001-611G3	Compressor Vane	38
	4012001-610G2	Turbine Vane	27
	4012001-612P1	Nut - Anchor	16
79	4012001-627G1	Support Arm	2
80	4012001-631P1	Ring	1
81	4012001-626G1	Support Arm	1
82	4012001-371P1	Magnetic Pickup	1
83	R297P04	Lockwire	AR
84	4012001-350G1	Support	8
85	42H-24095-3,5,7,9,&11	Insulation Blanket	1
86	42H-24094-3,5,7,9,&11	Insulation Blanket	2
87	4012001-357P4	Bolt	8
88	4012001-217P1	Spacer - Balance	AR
89	4012001-218P1	Washer	AR
90	4012001-374P1	Spacer	52
91	4012001-376P1	Shield - Gasket	2
92	4012001-378G1	Insulation Blanket	2

X376 PARTS LIST

Item	Drawing Number	Description	Qty. Req'd.
93	4012001-357P5	Bolt	26
94	1802-02	Nut	2

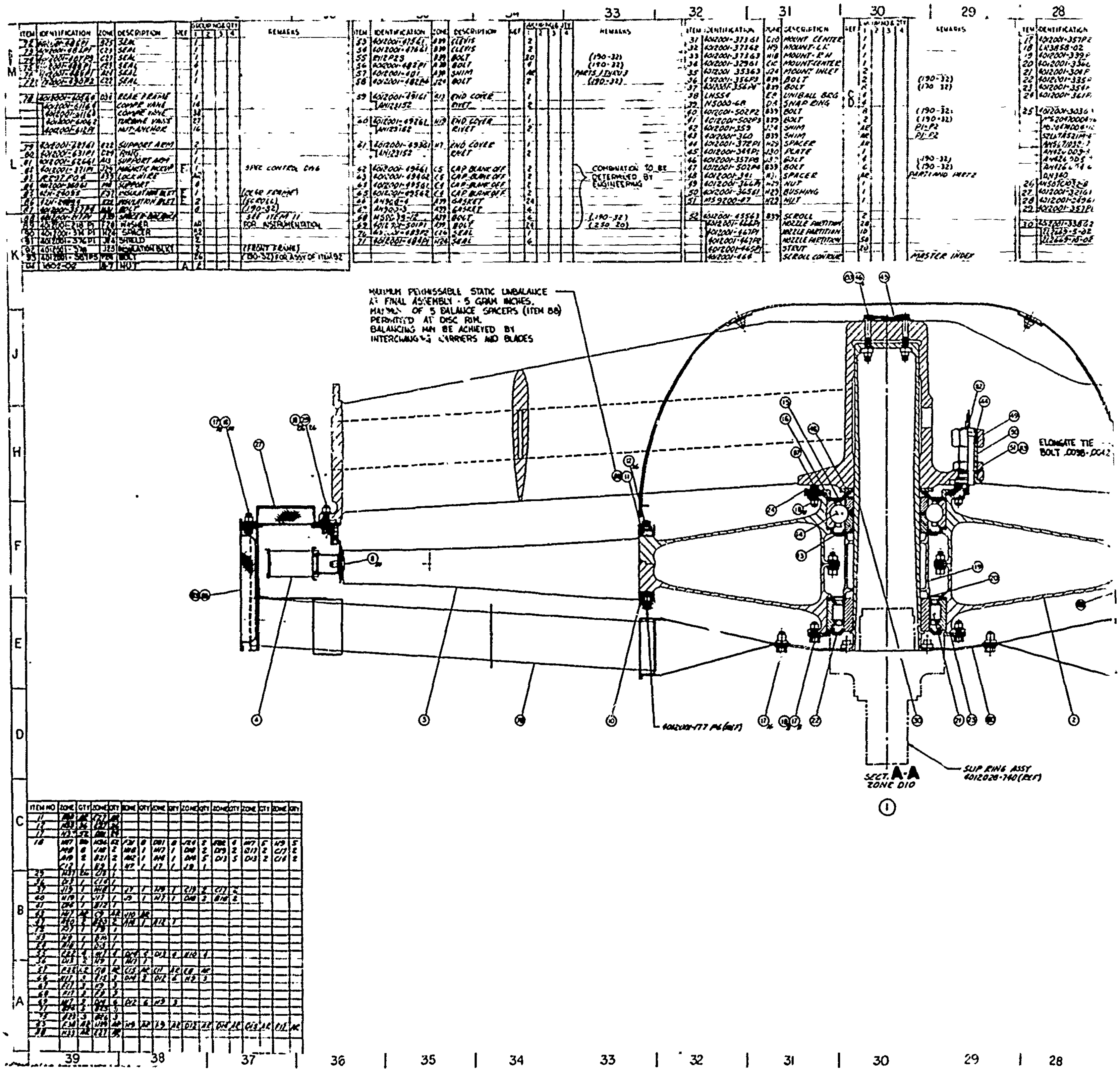
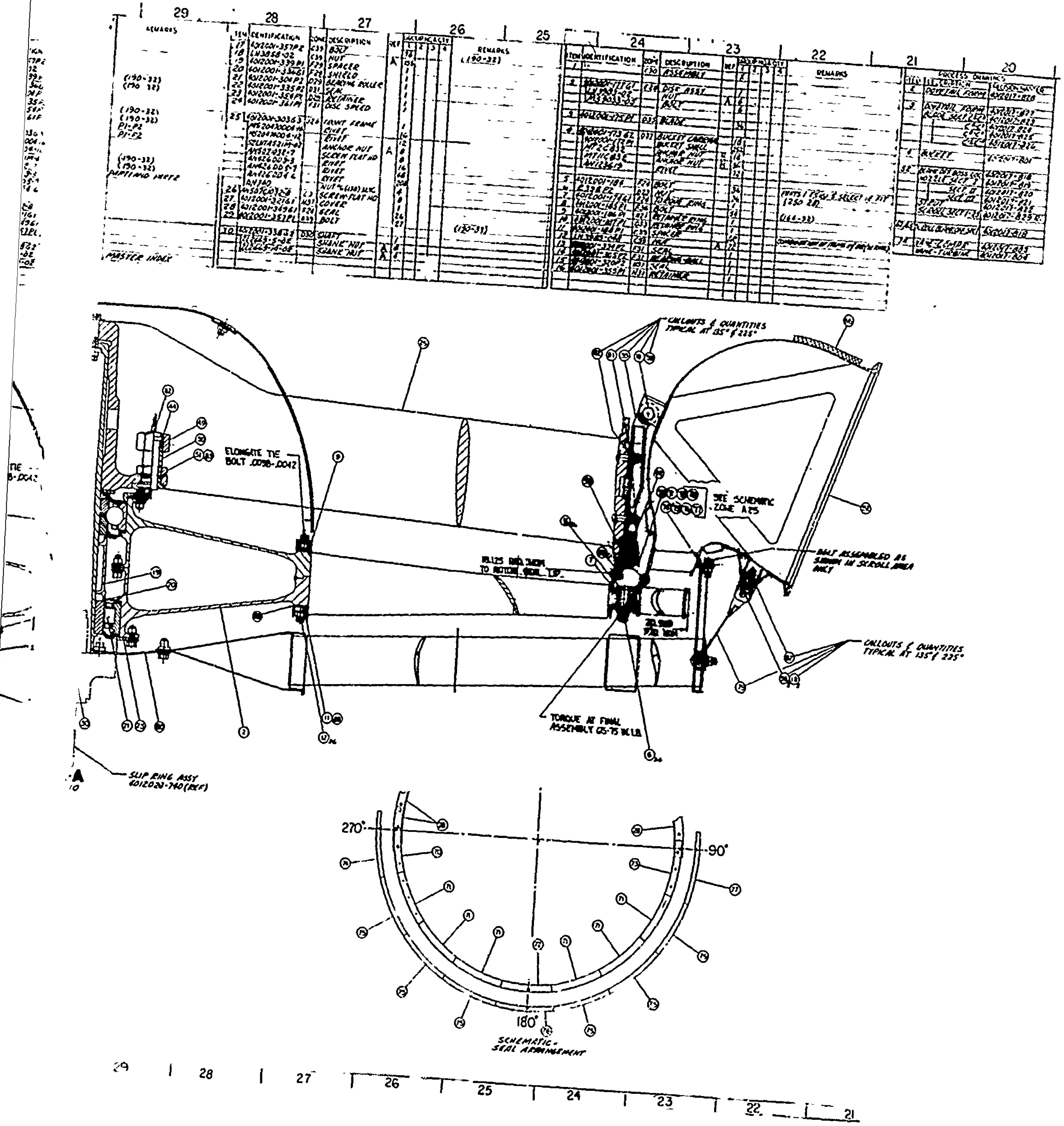


FIGURE 4.1 CROSS SECTION DRAWING X376 PITCH TRIM (4012001-940) Sheet 1 of 2



ING X376 PITCH TRIM CONTROL FAN
IM ~.eet 1 of 2

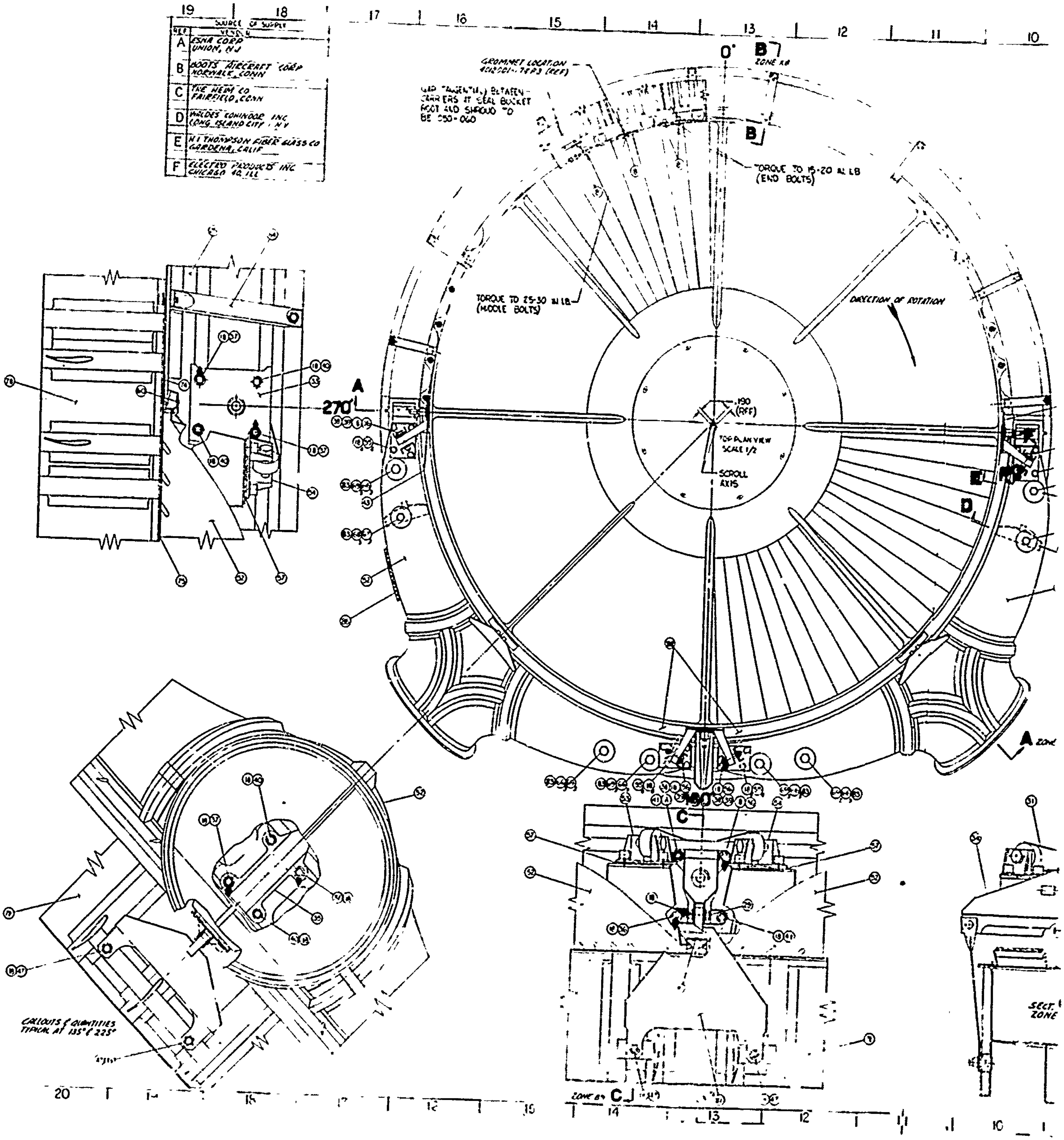
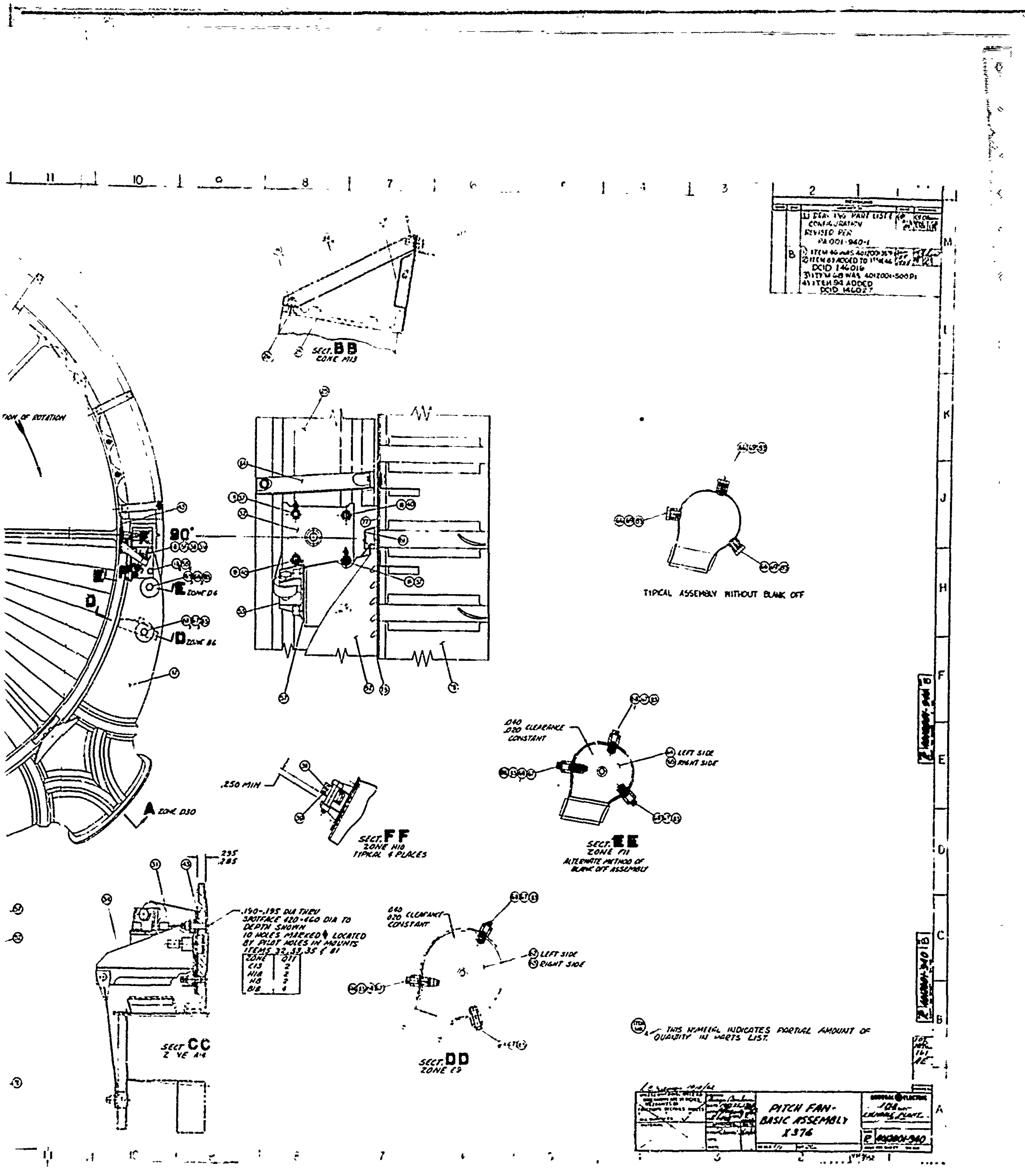


FIGURE 4.1 CROSS SECTION DRAWING X376 PIT
(4012001-940) Sheet 2 of 2



N DRAWING X376 PITCH TRIM CONTROL FAN
) Sheet 2 of 2

VIEW: Outside looking in; forward side of disc facing down.

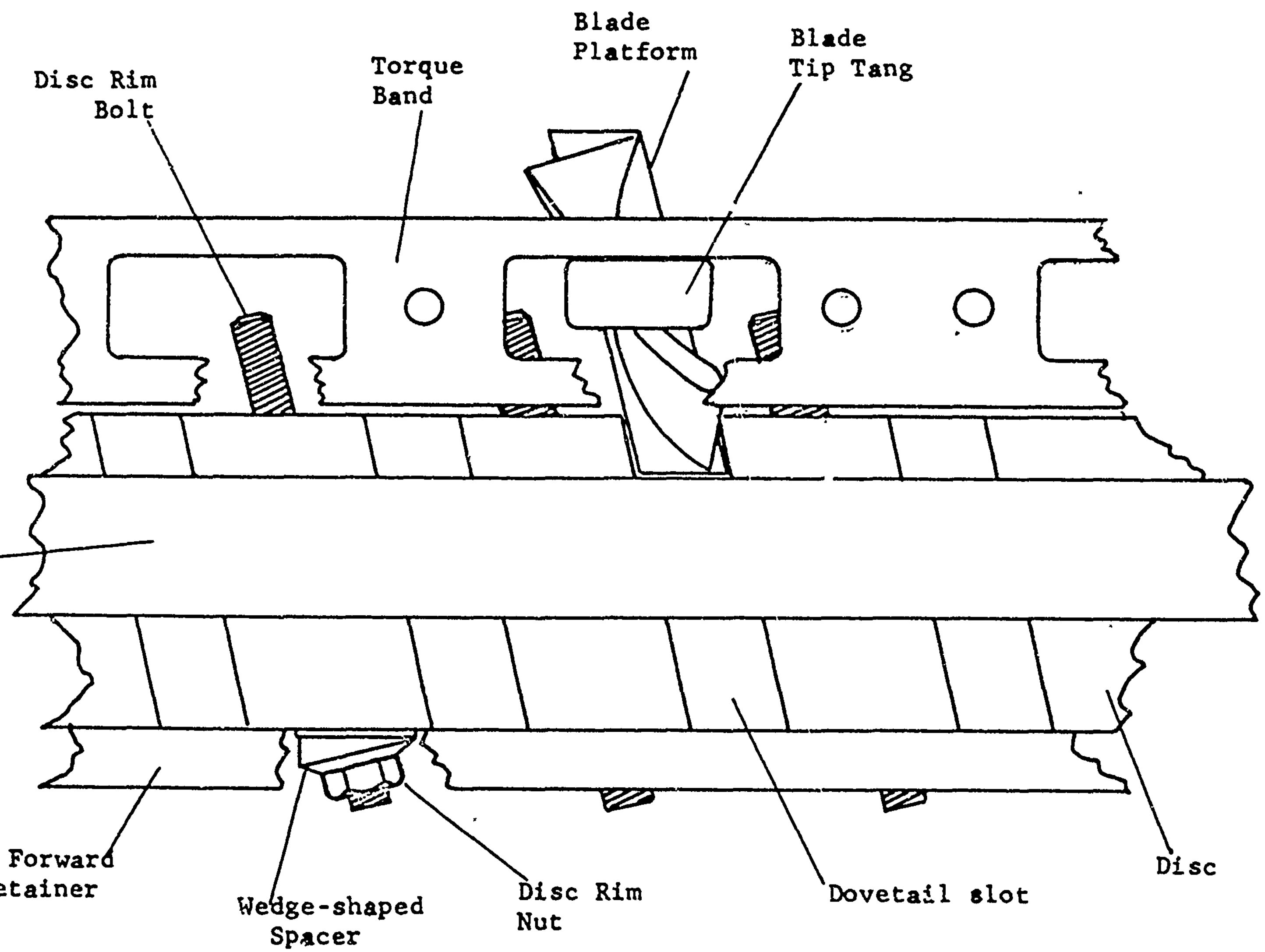
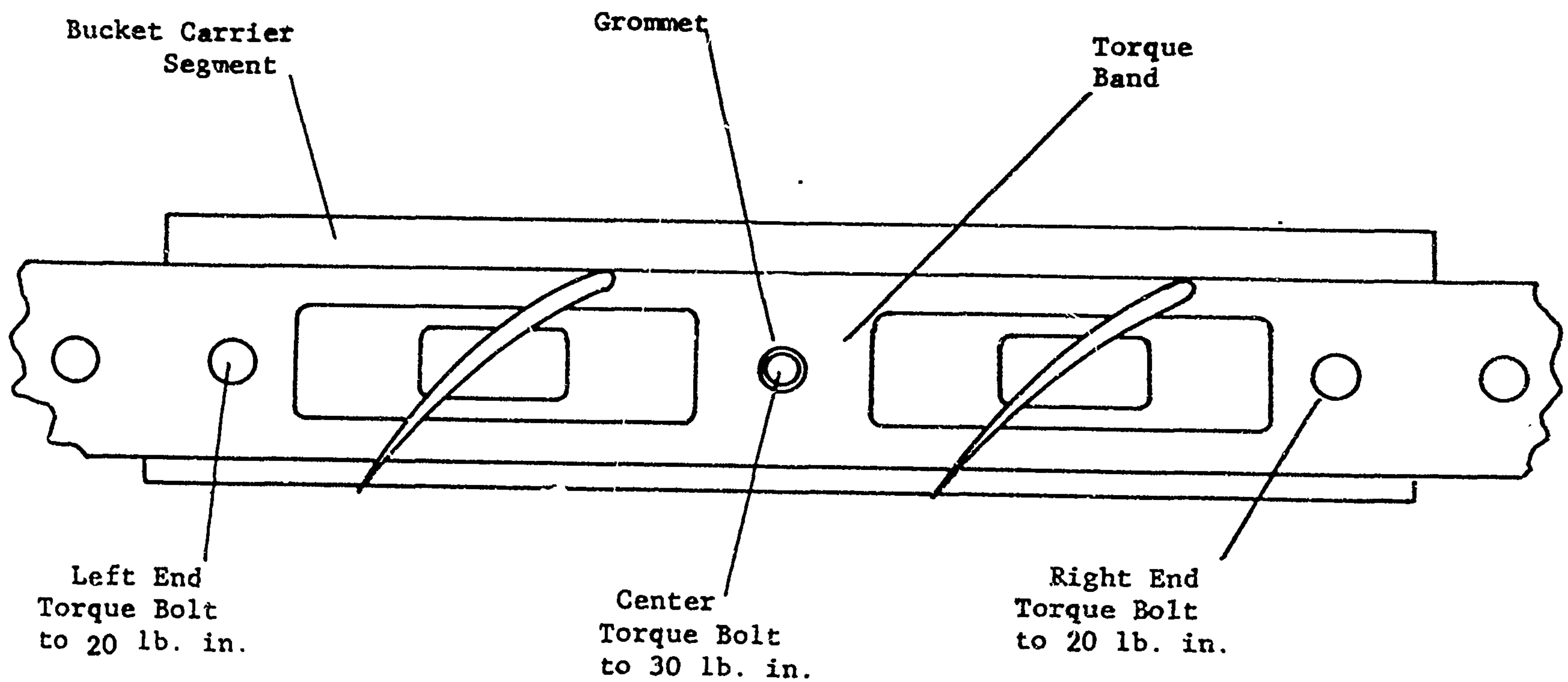
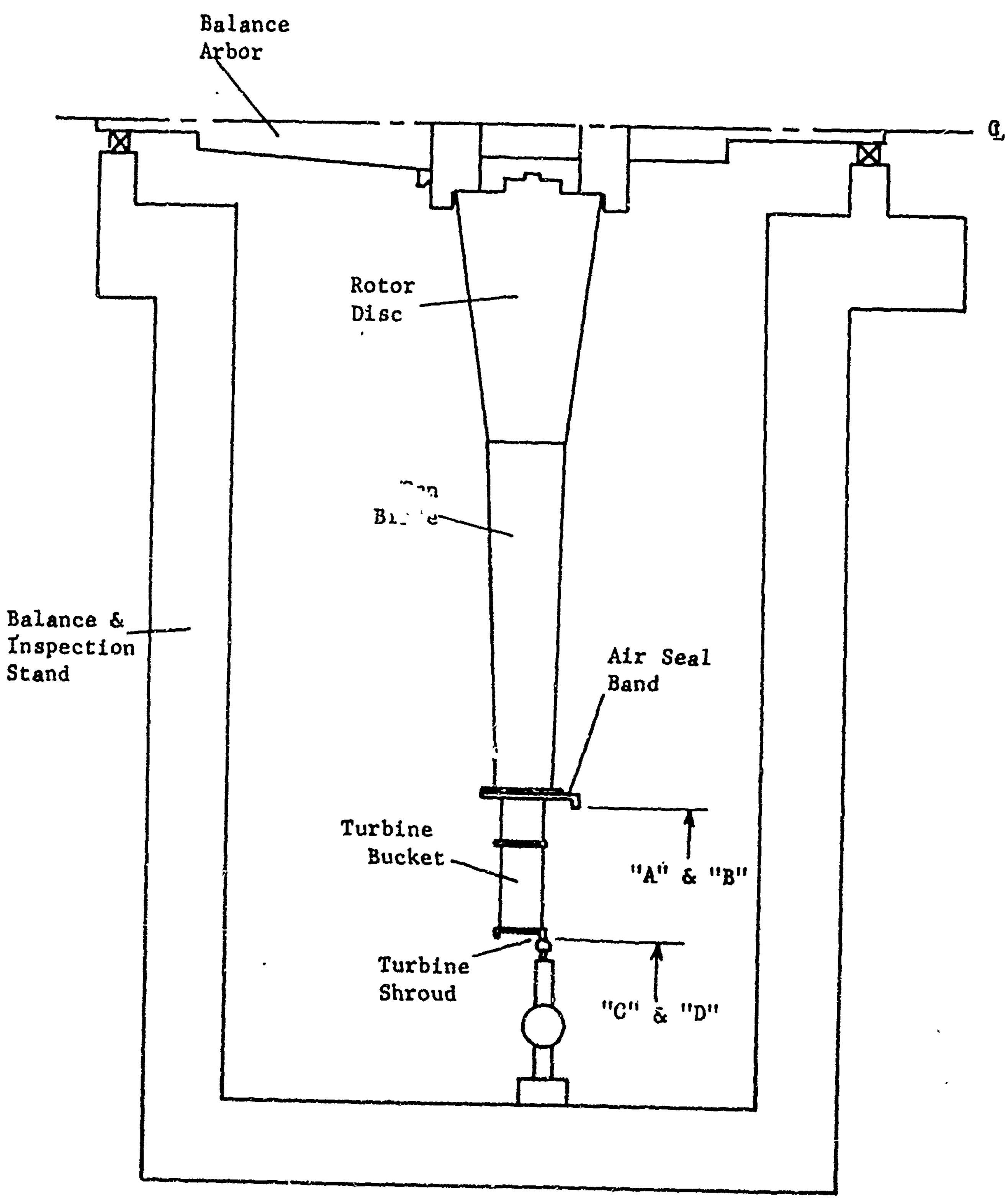


FIGURE 4.2 - ASSEMBLY OF BLADES TO DISC AND TORQUE RING TO BLADE TIP TANGS.



VIEW: Inside looking out; forward side of disc facing up.

FIGURE 4.3 - TORQUING PROCEDURE; TORQUE-BAND-TO-BUCKET-CARRIER-SEGMENT BOLTS.



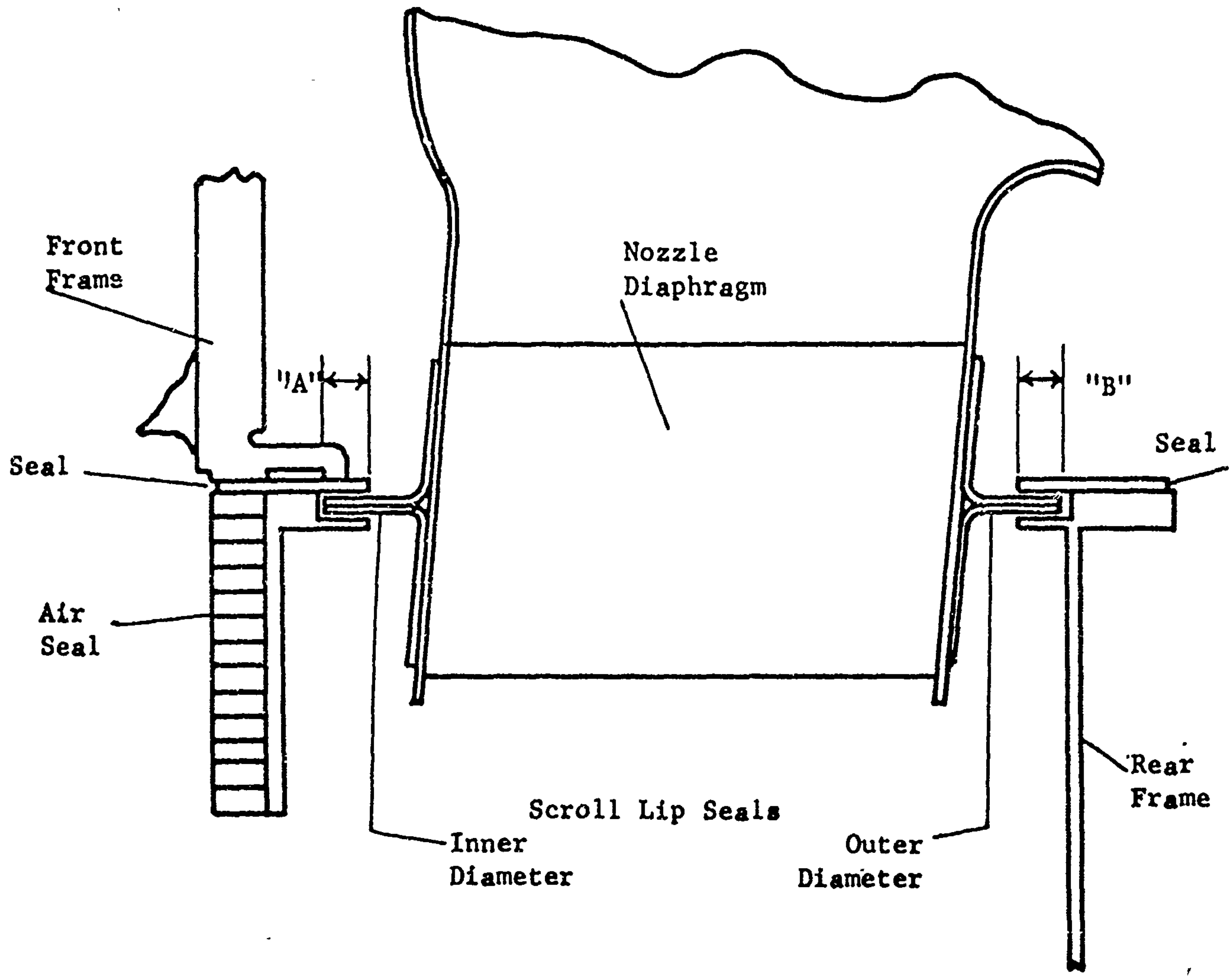
		Print Dimension	Actual Measurement	
A	Radius Max.	18.125" Nom	______	Location ____ Degrees
B	F.I.R.	± .030"	______	
C	Radius Max.	20.569" Nom	______	Location ____ Degrees
D	F.I.R.	± .030"	______	

FIGURE 4.4 - INSPECTION ROTATING AIR SEAL AND TURBINE TIP SHROUD

Bolt Number	1	2	3	4	5	6	7	8	9
Original Length	____	____	____	____	____	____	____	____	____
Final Length	____	____	____	____	____	____	____	____	____
Elongation									
Bolt Number	10	11	12	13	14	15	16	17	18
Original Length	____	____	____	____	____	____	____	____	____
Final Length	____	____	____	____	____	____	____	____	____
Elongation									
Bolt Number	19	20	21	22	23	24	25	26	27
Original Length	____	____	____	____	____	____	____	____	____
Final Length	____	____	____	____	____	____	____	____	____
Elongation									
Bolt Number	28	29	30	31	32	33	34	35	36
Original Length	____	____	____	____	____	____	____	____	____
Final Length	____	____	____	____	____	____	____	____	____
Elongation									

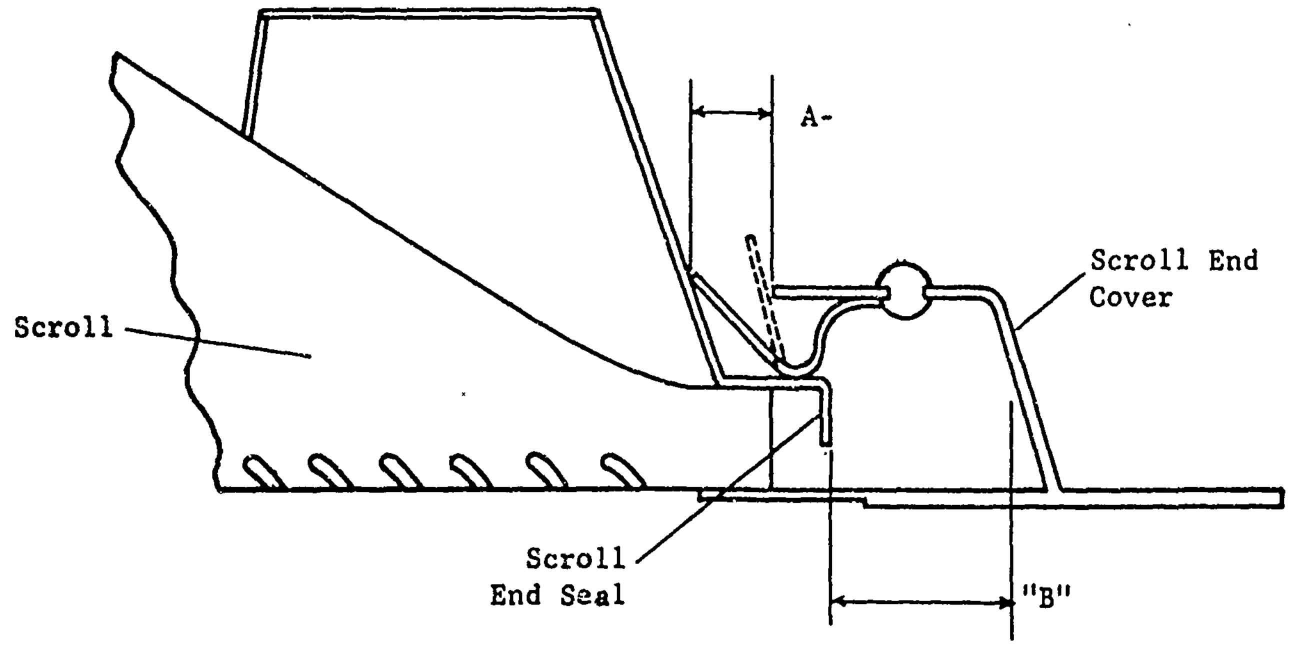
(NOTE: Maximum permissible elongation is 0.004 ± 0.0005")

FIGURE 4.5 - TORQUING PROCEDURE FOR ROTOR RIM BOLTS

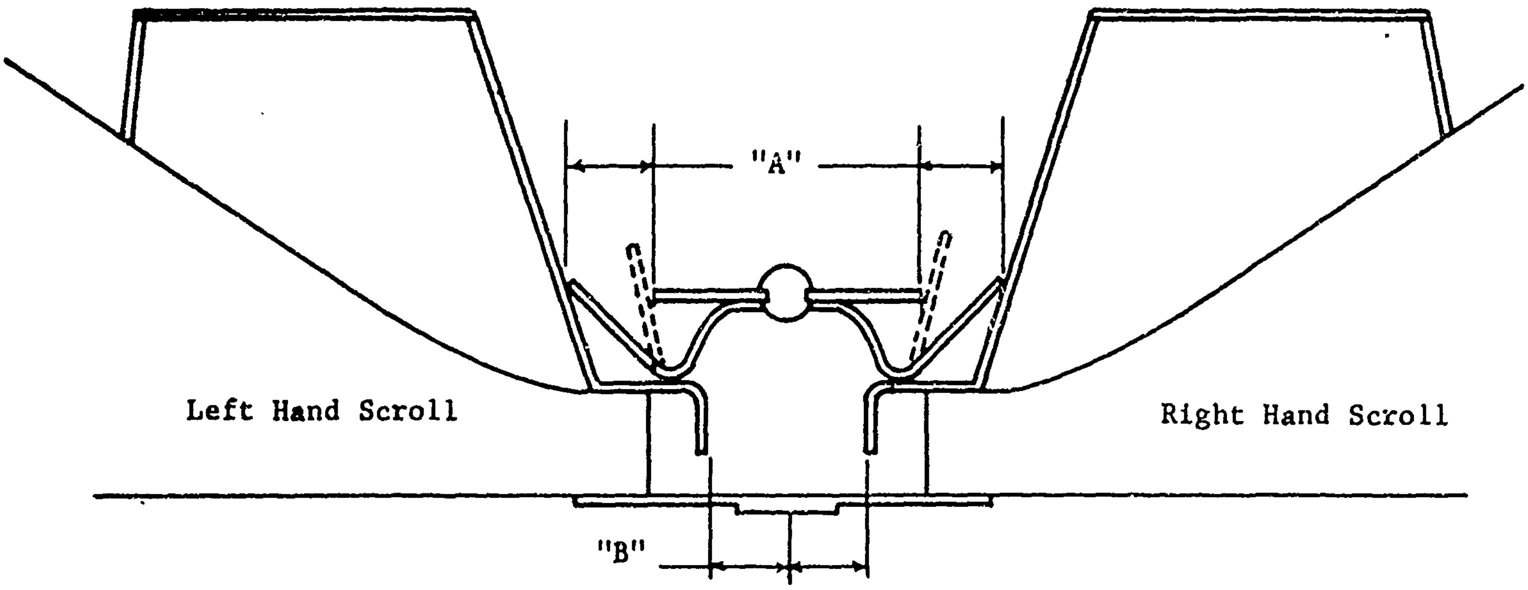


Location	Print Dimension	Actual Measurement			
		Right Hand Scroll		Left Hand Scroll	
A1 Scroll Ends	Maximum	Right End	______	Right End	______
		Left End	______	Left End	______
A2 Scroll Center	Nominal		______		______
B1 Scroll Ends	Min. 060"	Right End	______	Right End	______
		Left End	______	Left End	______
B2 Scroll Center	Nominal		______		______

FIGURE 4.6 - INSPECTION SCROLL LIP SEAL CLEARANCE



Typical view of scroll ends at 3 o'clock & 9 o'clock positions

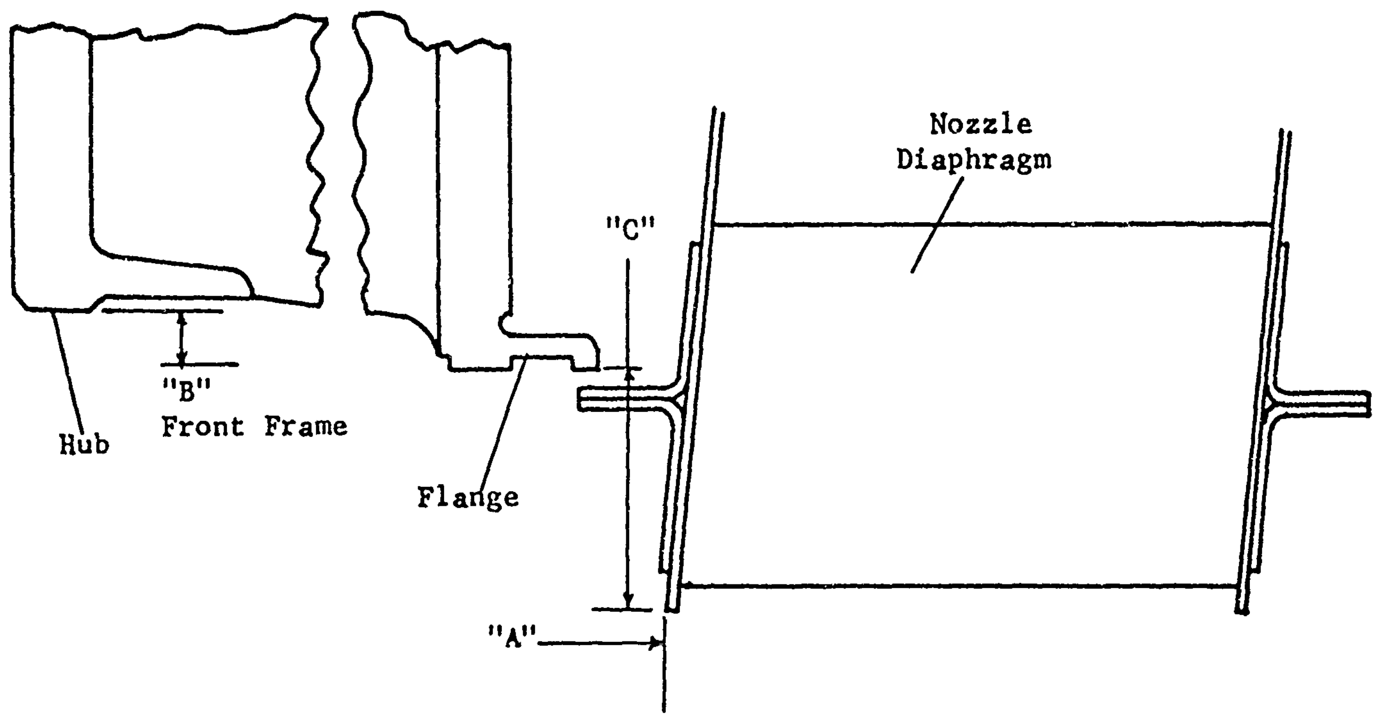


View of scroll ends at 6 o'clock position.

Inspect Dimensions "A" & "B" to establish minimum clearance of 0.200".

Right Hand Scroll			Left Hand Scroll		
Right End	A	______	Right End	A	______
	B	______		B	______
Left End	A	______	Left End	A	______
	B	______		B	______

FIGURE 4.7 - INSPECTION SCROLL END SEAL CLEARANCE



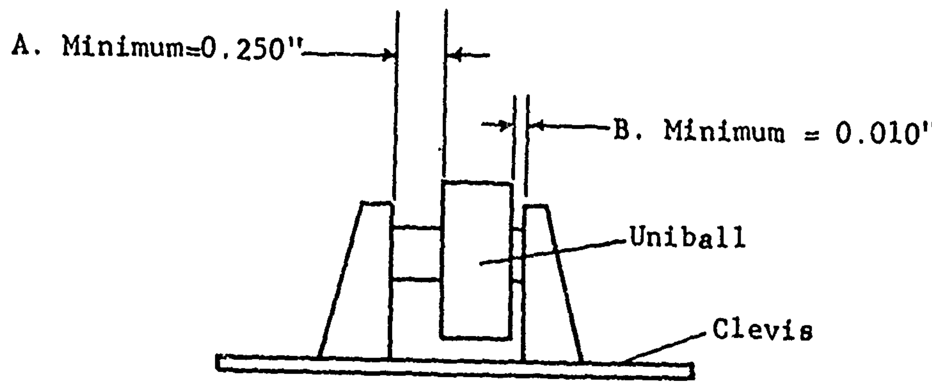
A. Measure distance from rotor centerline to scroll lip at the center. End radius must be equal.

Right Hand Scroll			Left Hand Scroll		
A1	Center	________	A1	Center	________
A2	Right End	________	A2	Right End	________
A3	Left End	________	A3	Left End	________

B. Measure height from aft face of flange to aft face of hub. ________

C. Measure maximum height from scroll exit lips to aft face of front frame flange. ________

FIGURE 4.8 - INSPECTION SCROLL-TO-FRONT-FRAME RADIAL & AXIAL DIMENSIONS



Right Hand Scroll

Right End
A ________
B ________

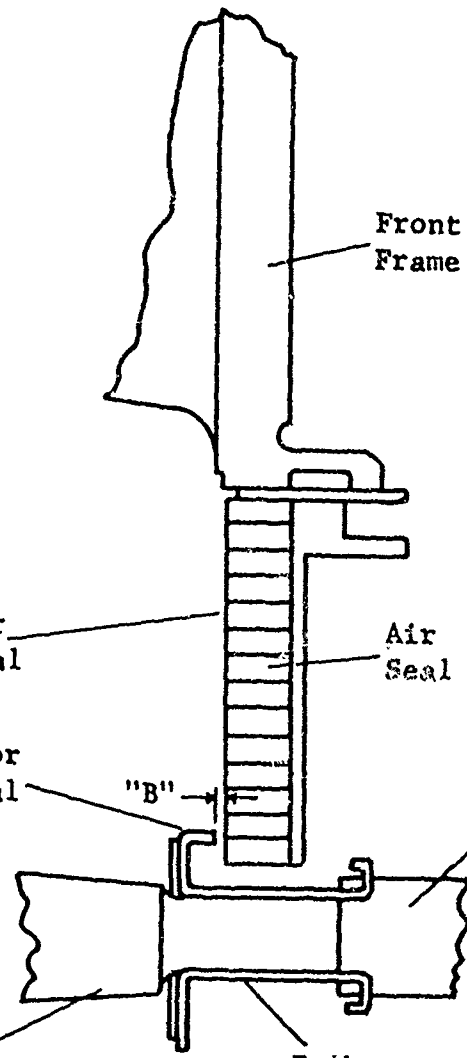
Left End
A ________
B ________

Left Hand Scroll

Right End
A ________
B ________

Left End
A ________
B ________

FIGURE 4.9 - INSPECTION SCROLL END CLEVIS SPACING



"A" Full Indicator Reading ________

Minimum Radius ________

NOTE: Mark location of minimum radius with Dykem.

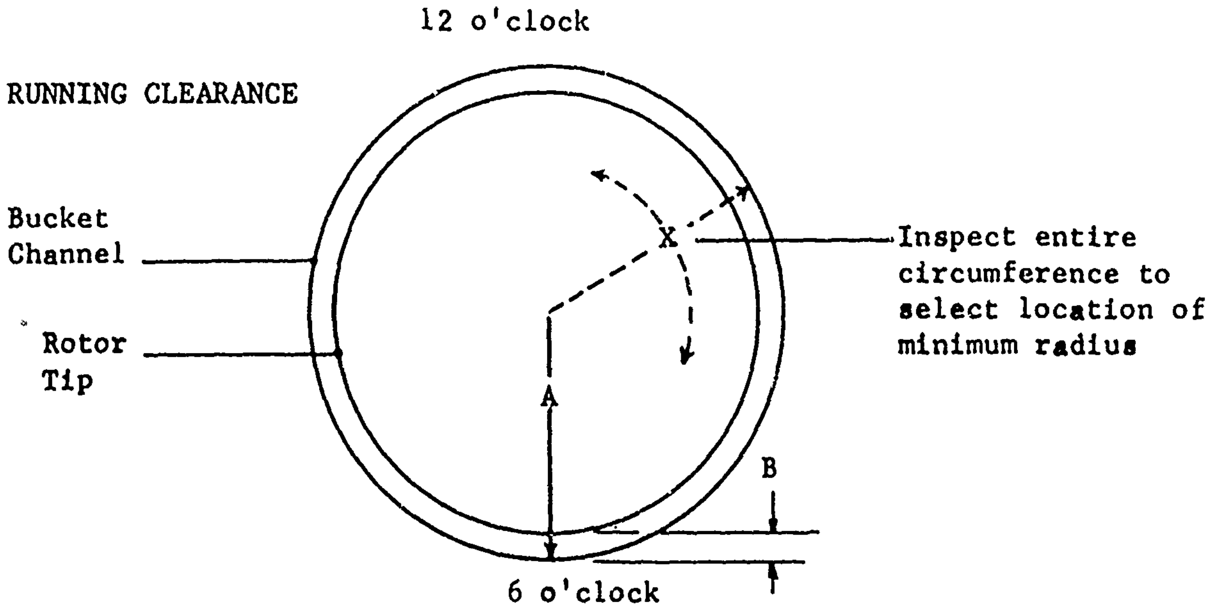
"B" Align Dykem marks on rotor seal lip and honeycomb seal and measure gap with feeler stock.

Minimum allowable gap 0.025"

Actual measurement ____"

FIGURE 4.10 - INSPECTION RADIAL CLEARANCE OF AIR SEAL

ROTOR RUNNING CLEARANCE



To compute rotor running clearance, follow steps 1, 2, 3, 4, and 5:

1. Rear frame bucket channel radius at 6 o'clock ("A") ... ________

2. Rear frame bucket channel minimum radius ("X") .... ________

3. Gap between high radius of rotor tip and bucket channel at 6 o'clock ("B") ... ________

4. Subtract step 2 from step 1 to obtain difference .... ________

5. Subtract step 4 from step 3 to obtain rotor running clearance .... Min. .200"

BEARING TRAVEL (Ref. Par 4.25.d)

Maximum allowable travel of bearing .036"

Actual travel ________

RUNOUT OF SPEED GENERATOR FACE (Ref. Par. 4.25.e)

Maximum allowable runout of speed generator disc 0.005"

Actual runout ________

FIGURE 4.11 · ROTOR INSPECTION RECORD

PITCH FAN CLEARANCES*

ITEM	CLEARANCE	B/P	ACTUAL	FLIGHT ALTITUDE
1	Shim	A/R		-
2	Speed Sensor (Axial)	.150" Min		Inverted
3	Speed Sensor (Radial)	.020 to .040"		-
4	Bulletnose (Radial)	.060" Min		-
5	Bulletnose (Axial)	.300" Min		Inverted
6	Rear Frame (Axial)	.250" Min		Normal
7	Air Seal (Radial)	.250 to .035"		-
8	Air Seal (Axial)	+.070 to -.030"		Normal
9	Air Seal (Axial)	.275" Min		Inverted
10	Rear Frame (Axial)	.300" Min		Normal
11	Rear Frame (Radial)	.200" Min		-
12	Scroll (Axial)	.400" Min		Inverted
13	Bearing Play (Axial)	.036" Max		-

*Refer to Dwgs. 4.12, 4.13, 4.14.

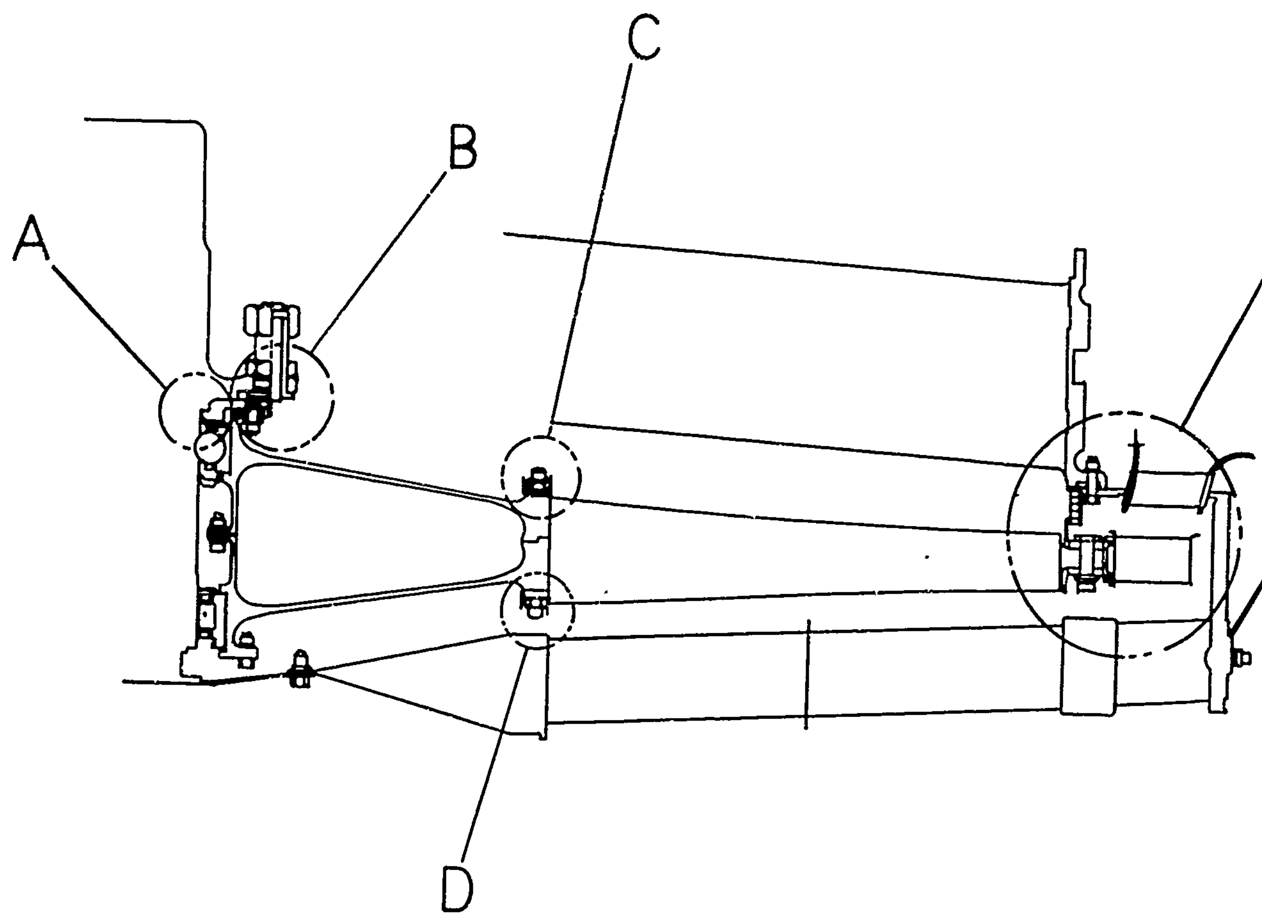


Figure 4.12 Pitch Fan Clearances

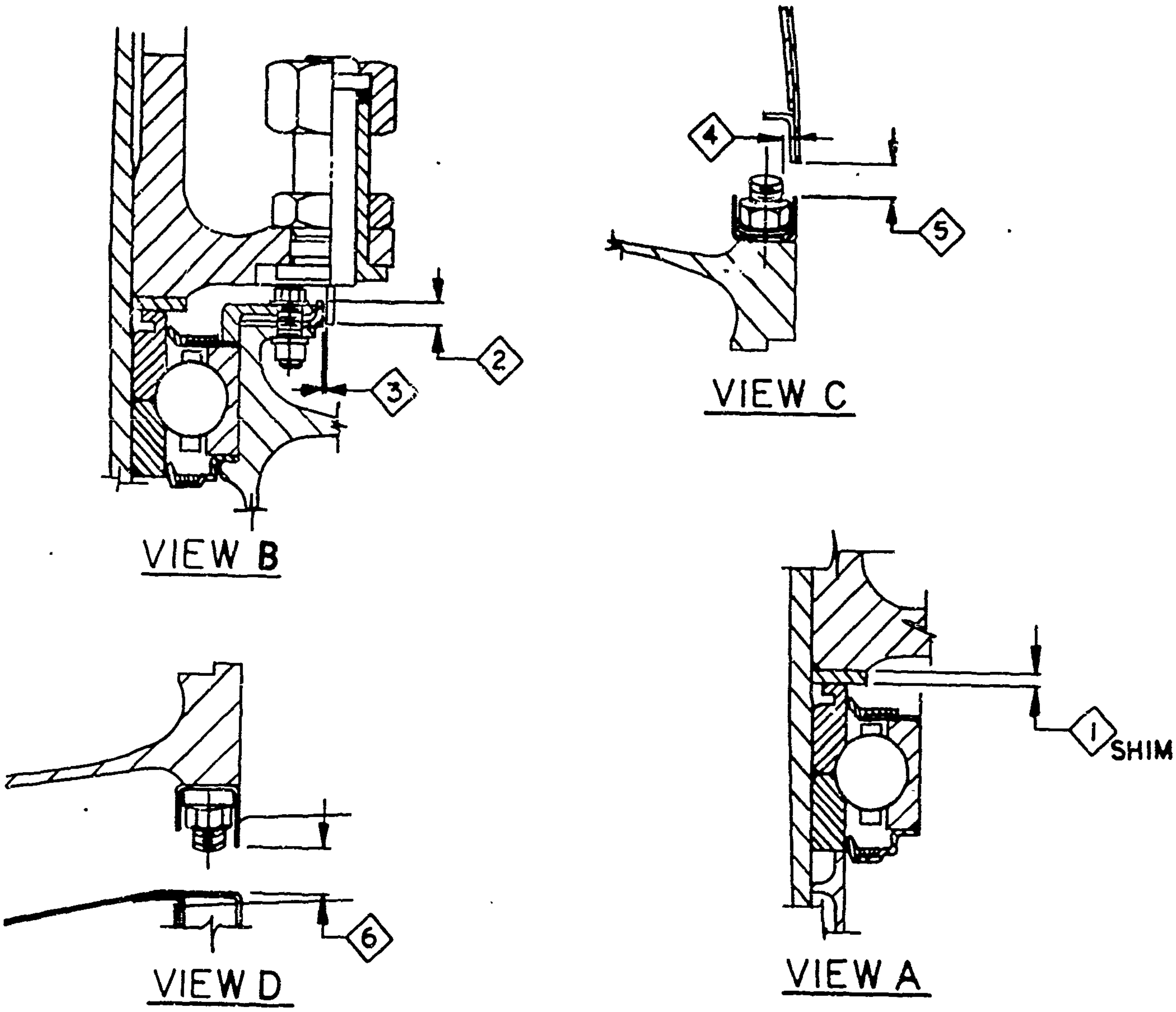


Figure 4.13 Pitch Fan Clearances

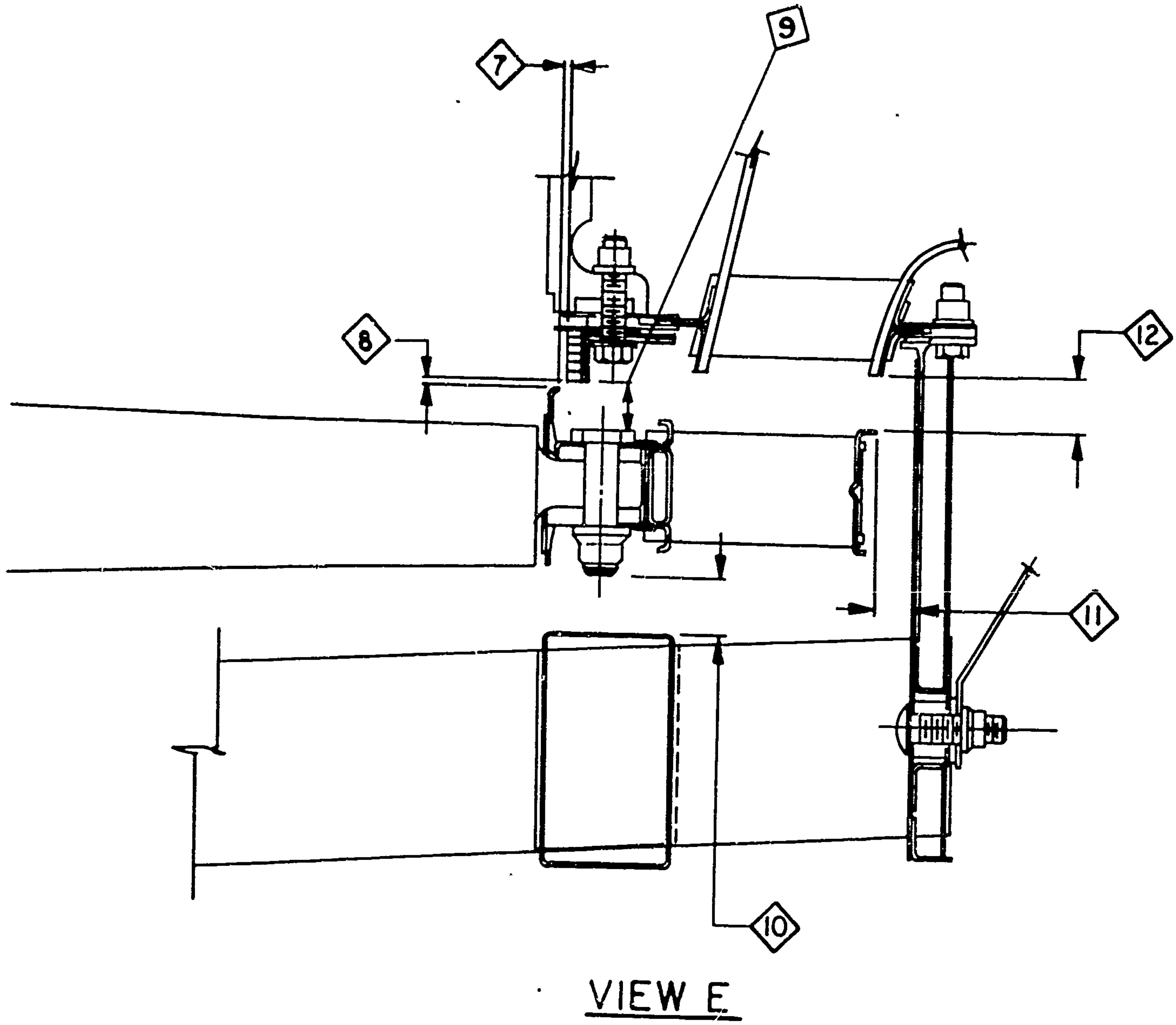


Figure 4.14 Pitch Fan Clearances

SECTION 5.

INSTALLATION

5.1 INSTALLATION PROCEDURE

The procedures for installation of the X376 pitch control fan into the XV-5A aircraft is to be provided by the airframe manufacturer.

5.2 Installation Design Data

All installation design data is provided in the XV-5A Specification #113.

SECTION 6.

X376 PITCH TRIM CONTROL FAN DISASSEMBLY

6.1 REMOVAL FROM SHIPPING CONTAINER

a. Remove the pitch trim control fan from the shipping container and set it up on the build-up stand (Par. 3.4) in the inverted flight position.

6.2 REMOVE REAR FRAME

a. Remove the rear frame insulation blanket and the center cover.

b. Remove the six screws which hold the rear frame-to-scroll brackets.

c. Remove the bolts and nuts from the outer flange.

d. Lift the rear frame from the assembly taking care to guide the rear frame over the rotor tip.

6.3 REMOVE ROTOR

a. Position the pitch fan in the flight position and remove the bulletnose cover.

b. Position the pitch fan in the inverted flight position. Remo four screws which extend through the front frame hub into the end of the rotor shaft. Heat the hub section of the front frame with three or four heat lamps for approximately 30 minutes or until the interference between the shaft and front frame is eliminated.

c. Lift the rotor and shaft from the front frame.

6.4 REMOVE SCROLLS

a. Remove the three pins that support the scroll at the center and end mounts.

b. Slide the scrolls radially outward to disengage the scroll finger seals. Then move the scroll up to clear the brackets.

6.5 DISASSEMBLE FRONT FRAME

6.6 Remove Air Seals

a. Remove the air seal segment bolts and nuts, and remove the air seal segments.

6.7 Remove Covers

a. After the seal segments have been removed, lift the cover to remove it from the front frame.

6.8 Remove Speed Pick-up

a. Remove the retainer nut from the speed pick-up bushing and slide the magnetic pick-up from the bushing. Remove the jam nut from the bushing and slide the bushing from the front frame.

6.9 Remove Mounts

a. Remove scroll and rear frame mounts by removing four bolts from each mount.

6.10 DISASSEMBLE ROTOR

6.11 Remove Carrier Segments

a. Remove the torque bolts which are located between each blade.

b. Remove two carrier bolts from each segment and slide the carrier segment from the blade tangs.

6.12 Remove Blades

a. Position the fan in the inverted flight position and remove 36 nuts which hold the aft retainer ring. Remove the aft retainer ring and slide the blades up in the disc slots to a position which will permit the blades to be removed from the disc slots and the torque band.

b. Remove all but six blades. The remaining six blades should be equally spaced around the rotor disc to support the torque band.

c. Remove the torque band; then remove the remaining six blades.

d. Remove 36 nuts which hold the forward retainer ring and remove the retainer.

6.13 Remove Shaft

a. Position the disc with the aft face down and the shaft end pointing up. Remove the top half of the thrust bearing inner race using the puller referenced in Par. 3.3.

b. Remove the shaft by sliding it through the disc toward the aft side.

c. Remove both inner races from the shaft using the puller referenced in Par. 3.3.

d. Remove six bolts from the thrust bearing retainer. Remove the retainer, speed generator, top grease seal, and the balls and cage.

e. Pull the thrust bearing outer race from the disc using the puller referenced in Par. 3.2. Remove the bottom grease seal.

f. Invert the disc and remove the six bolts from the roller bearing retainer. Remove the retainer and bottom grease seal.

g. Remove the roller bearing outer race from the disc using the puller referenced in Par. 3.2. Remove the top retainer ring.

6.14 SCROLL DISASSEMBLY

a. Disassemble the two scroll end clevises by removing four bolts from each clevis.

6.13 Remove Shaft

a. Position the disc with the aft face down and the shaft end pointing up. Remove the top half of the thrust bearing inner race using the puller referenced in Par. 3.3.

b. Remove the shaft by sliding it through the disc toward the aft side.

c. Remove both inner races from the shaft using the puller referenced in Par. 3.3.

d. Remove six bolts from the thrust bearing retainer. Remove the retainer, speed generator, top grease seal, and the balls and cage.

e. Pull the thrust bearing outer race from the disc using the puller referenced in Par. 3.2. Remove the bottom grease seal.

f. Invert the disc and remove the six bolts from the roller bearing retainer. Remove the retainer and bottom grease seal.

g. Remove the roller bearing outer race from the disc using the puller referenced in Par. 3.2. Remove the top retainer ring.

6.14 SCROLL DISASSEMBLY

a. Disassemble the two scroll end clevises by removing four bolts from each clevis.

SECTION 7.

INSPECTION, REPAIR AND REPLACEMENT

7.1 GENERAL

a. This section provides initial field maintenance guidelines for the X376 Pitch Trim Control Fan. These guidelines are based on development test experience and design analysis. The thin sheet metal used in construction of the fan is subject to nominal contour distortions; however, the distortions normally will not adversely affect the performance or life of the parts. In the following tabulation (Table 7.2, Maximum Serviceable Limits and Repair Limits), an asterick (*) is placed at items which represent conditions which should be expected to exist after normal operation. For example, the staggered sawcuts in the rear frame flanges often break through or distort. These would be cut through at manufacture except that machining of the large flange is made easier by retaining the flange as an integral piece. Such a condition after operation is to be expected and is normal. Questions concerning any hardware conditions not adequately described should be referred directly to the General Electric Company.

7.2 CLEANING AND INSPECTION

a. The following paragraphs (7.3, 7.4, 7.5, 7.6, 7.7 and 7.8) and Table 7.1 outline recommended general procedures for cleaning and inspecting fan hardware.

7.3 Cleaning of Bearings

NOTE

Clean ball and roller bearings in a separate area (removed from the general cleaning area). Keep this area free of dust and lint and well lighted.

a. To clean used bearings:

(1) Loosen oil and grease by soaking the bearings in an agitated solution, Specification MIL-L-6082. Maintain this solution at a temperature of 106°C to 122°C (225°F to 250°F). As an alternate, Federal Specification P-S-661 may be used, provided it is used at room temperature only. If bearings are coated with carbon, a compound carbon remover, such at Turco-Fuzee (or equivalent), may be added to the solution to increase the effectiveness of the cleaning operation. Soaking time varies from 30 minutes to several hours, depending on the type and amount of contaminant to be removed.

(2) After cleaning, rinse the bearings in a clean solution, Federal Specification P-S-661. To this solution, add 3 percent to 5 percent (by volume) of anti-corrosion oil, Specification MIL-L-7870 (or MIL-L-6085). This oil prevents the formation of corrosion when bearings are dry.

(3) To dry bearings, flow filtered, heated, clean, dry air (under pressure) over all of the parts.

NOTE

Do not handle cleaned bearings with bare hands. Wear clean, lint-free gloves (such as surgical gloves) or gloves made of neoprene or nylon. Keep all handling to a minimum to reduce the possibility of damage or contamination. Do not remove bearings from the cleaning and inspection area in a dry condition.

b. To clean new bearings; Open anti-friction bearings are normally preserved with oil or a preservative compound. Before installation of these bearings, remove the preservative compound by washing the bearings in a bath of a continuously filtered solvent, Specification P-S-661, or warm lubricating oil, Specification MIL-L-6082. Bearings preserved in oil require no depreservation prior to use.

7.4 Fluorescent-Penetrant Method of Inspection (Zyglo)

7.5 General

Inspection by the fluorescent-penetrant method, Specification MIL-I-6866, is a nondestructive means of testing nonferrous parts for cracks and defects that have openings to the surface. A highly fluorescent, water-emulsifying, low-viscosity oil is applied to a completely clean surface, and allowed to penetrate any flaws. The surface oil is then removed. The residual oil which has penetrated the flaws glows when exposed to ultraviolet light, thus revealing the extent of the defects.

7.6 Cleaning Prior to Application of Fluorescent-Penetrant

Be sure surfaces to be inspected are free of foreign materials (such as heavy oil, grease, rust, or scale) which would either prevent penetration of the oil, or indicate false flaws by absorbing the penetrant. Polishing causes false indications because displaced surface metal can cover defects and thereby close the surface openings of deeper flaws. Remove heavy oils by degreasing, and remove dirt and scale by the applicable cleaning method.

7.7 Application of Fluorescent-Penetrant Oil

Apply the fluorescent-penetrant oil by immersing the part, or by flowing the oil over it. Allow approximately one hour for the oil to penetrate into the surface openings. Immerse in the emulsifier and drain 3 to 5 minutes. Apply a warm-water spray to remove excess oil from the part, so that only the oil which has penetrated deeply into the flaws remains. Dry the part in a soft flow of warm, dry air.

7.8 Application of Developer

After all excess fluorescent oil has been removed, cover the part with developing powder. The developer draws the oil trapped in the defects to the surface. When the part is examined in a darkened booth under ultra-violet (black) light, the oil that is developed from the defects is readily visible. The nature and extent of the flaws can be determined by the extent of the development around the defects.

WARNING

Developing powder is not harmful to inhale, but can be annoying in a heavy concentration. Dermatitis is apt to result if the penetrating oil remains on the skin for several days. To avoid this, use brackets to hold the parts and neoprene gloves when necessary. The presence of penetrating oil on the skin can be detected under black light.

7.9 Cleaning of Titanium

Cleaning of titanium to remove relatively loose materials such as soils and grease using liquid solvents is acceptable provided chlorine or chlorine compounds or any of the halogens, e.g. fluorine, bromine, iodine, astatine, which are very erosive to titanium, are prohibited.

A suggested procedure is as follows:

a) Wipe off loose grease.

b) Swab solvent (acetone, methyl ethyl ketone) onto the part with a clean, absorbent cloth.

c) Scrub the part with a fiber brush.

d) Repeat operations (b) and (c) until no soils and oil are visible on the part.

e) Wipe remaining solvent from the part with a clean, absorbent cloth.

An alternate cleaning method is the use of vapor blasting - the following parameters are recommended:

a) 1200 mesh abrasive, e.g. garnet, walnut shell.

b) 90-100 psi filtered air pressure.

c) Vapor blast at angle of less than 45° from the surfaces being blasted.

TABLE 7.1

X376B FAN CLEANING AND INSPECTION METHODS

Part	Cleaning Procedure	Inspection Method
Front Frame	Degrease	Spot Zyglo
Rear Frame	Degrease	Spot Zyglo Braze Area
Scroll	Degrease	Spot Zyglo Weld and Braze Area
Seals	Vapor Hone	Zyglo
Blades	Vapor Hone Airfoil (Note: Mask Dove-Tail and Tang) .	Zyglo
Disc	Clean by Hand with Alcohol	Zpot Zyglo Bearing Housing and Dovetail Slots
Carriers	Vapor Hone	Zyglo
Torque Band	Degrease	Zyglo
Bearing	Refer tp Para. 7.3	Magnaflux
Mounts	Degrease	Zyglo

TABLE 7.2

MAXIMUM SERVICEABLE AND REPAIR LIMITS

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>NASA 36" Front Frame</u>			
1. Struts & Outer Shells			
a) Nicks and Scratches	0.003" deep except in fillet areas of struts to outer ring where none are allowable.	0.010" deep	Bench to blend smoothly.
b) Cracks	None allowable.	No limit.	a) Weld prep. b) Weld repair - welds must be inert arc, must comply with G.E. M50T1A, and must be backed with Argon. c) Filler material to be Hastelloy X.
2. Dome			
a) Nicks and Scratches	0.003" deep	0.010" deep	Bench to blend smoothly.
b) Cracks	None allowable	No limit	a) 1/4" stop drill to 1/16" diameter. b) Over 1/4" Patch using 1/8" dia. rivets and 0.030" sheet, see frame drawing.

TABLE 7.2

MAXIMUM SERVICEABLE AND REPAIR LIMITS

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Pitch Fan Front Frame</u>			
* 1. Nicks and scratches	.005" deep except in fillet areas of struts to outer ring where none are allowable.	.020" deep	Bench to blend smoothly.
2. Cracks	None allowable.	No limit - to be reviewed by G.E.	To be reviewed by G.E. Eng.
* 3. Surface coating removal	No limit	No limit	Touch-up per dwg. 4012001-303.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Shaft</u>			
1. Cracks	None allowable	Not repairable	Replace
2. Shank nuts			
A. Looseness	No limit	No limit	Replace if assembly prevented.
B. Loss of locking	Not allowable	Not repairable	Replace.
3. Nicks and scratches except bolt flange area	None allowable	.002" deep	Blend smoothly.
<u>Bearings</u>			
1. End play and radial clearance	Dwg. 4012001-304 and 305 requirements	Not repairable	Replace
2. Wear - including surface condition	Maintenance judgement	Not repairable	Replace
3. Rust	None allowable	No limit	a) Remove using crocus cloth and oil. b) Coat with MIL 7808 for storage.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
Grease Seals			
1. Lip edge for tears, transverse grooves and resilience	None allowable - maintenance judgement	Not repairable	Replace
Speed Sensor			
1. Cracks	None allowable	Not repairable	Replace
2. Radial run-out of teeth	Dwg. 4012001-371 limits	Not repairable	Replace
3. Nicks & burrs except in radius of teeth	.005" deep and raised material	.005" deep - no limit on raised material	Bench to blend smooth.
Cover			
1. Cracks	1/16" long except in tab radii where none is allowable	1/4 inch long	Weld repair using Hastelloy W.
* 2. Dents	Maintenance judgement	Maintenance judgement	Replace
Mounts			
1. Cracks	None allowable	Not repairable	Replace
2. Scratches, nicks & dents	.006" deep	.010" deep	Bench to blend smooth.
Forward Air Seal			
1. Braze of honeycomb to sheet cracks	20% of area located within border of outer edge	Not repairable	Replace
2. Buckles	Maintenance judgement	No limit	Straighten, check bolt torque.

TABLE 7.2
MAXIMUM SERVICEABLE AND REPAIR LIMITS

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Pitch Fan Scroll</u>			
1. Cracks or Cuts A) Skins & Hats	1/4 inch	No limit	a) 1/4" or less 1) Surface crack less than 1/3 matl. thickness - blend effected area. 2) More than 1/3 matl. thickness - Stop drill with .06 dia. holes, if hot gas leakage can be tolerated. b) Over 1/4 inch or if leakage cannot be tolerated - bench out crack and repair using Hastelloy X filler material using inert gas back up.
B) Nozzle Partitions 1) Trailing Edge	1/10 inch	No limit	a) 1/10" or less-bench out crack and blend to form smooth profile. b) 1/10" or more-braze with gold nickel filler matl. blend to match airfoil contour.
2) All Other Areas	1/8 inch	No limit	a) 1/8" or less-bench out crack and blend to form smooth profile.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
			b) Over 1/8"-bench out crack and repair weld using Hastelloy X filler material. Blend to match airfoil contour.
C) Struts	1/8 inch	No limit	a) 1/8 or less-blend to form smooth contour b) 1/8 or more-bench out crack and repair weld using Hastelloy X filler material. Do not bench weld after repair.
D) Welds	1/4 inch	No limit	a) 1/4 inch or less-stop drill using .06 dia holes if leakage can be tolerated. b) Over 1/4 inch or if leakage cannot be tolerated - bench out crack and repair weld using Hastelloy X filler material. Do not bench weld after repair.
E) Braze Joints	1/4 inch	No limit	Clean joint and T.I.G. braze with AMS 4777 cast rod.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
* 2. Nicks & Scratches	No limit provided material thickness not reduced greater than 1/10 material thickness	No limit	a) Less than 1/10 material thickness-blend affected area b) Over 1/10 material thickness, repair same as crack
* 3. Dents & Bulges	No limit provided operation or assembly is not affected	Same as Max. Serviceable Limits	Rework to approximately original contour.
<u>Pitch Fan Rotor</u> <u>Disc Assembly (Except Dovetails)</u>			
1. Cracks	None allowed	Not repairable	Replace
2. Dents, Nicks, Scratch	None Allowed	Any number .003"-.005" depth	Blend, polish, no high metal or sharp bottoms
3. Bolt Holes for Damage	None allowed	10% increase in hole diameter, .010 decrease in flange thickness	Ream hole, blend polish tang faces, radius edge of hole, no sharp edges or high metal.
4. Bolt Stubs for Axial Misalignment	Misalignment permitted as long as nut-retainer ring assembly leaves at least 2 threads beyond edge of nut	Reposition for symmetry on both faces of disc rim	Reposition by jacking with lock nut.
5. Vent Holes for Foreign Matter	None allowed	Holes must be clear of foreign matter	Clean hole with probe.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
6. Bolt Stubs for Thread Damage	Any amount except at transition to bolt body as permitted by proper assembly of lock nut - no nicks permitted at transition to bolt body.	Threads - de-burring permitted as long as lock nut assembly is not affected. No loose nuts - should not take no go gage.	De-burr to limit - replace if accepts no-go gage or nicks at thread-body transition.
Disc Rim Dovetail Slots			
1. Cracks	None allowed	Not repairable	Replace
2. Dents, Nicks, Scratches on D/T Profile	None allowed	Any number .003"- .005" depth	Blend and polish - edge of slot must be radius.
3. Dents, Nicks, Scratches on D/T Pressure Face	None allowed	Not repairable	Replace & refer to G.E.
4. Bottom of D/T Slot for Dents, Nicks, Scratches	None allowed	Any number .003" - .005" deep	Blend & polish - no high metal
5. Fretting	None allowed	Not repairable	Refer to G.E.
Disc Rim Lock Nuts			
1. Cracks	None permitted	Not repairable	Replace
2. Locking Action	Must be within Spec. tolerance	Not repairable	Replace
Wedges			
1. Cracks	None permitted	Not repairable	Replace
2. Nicks, Dents, Scratches	Any number .001"-.003" deep up to 1/4" long	Any number .003"-.005" deep up to 1/2" long	Blend, polish - must maintain wedge angle tolerance.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
3. Hole Damage	No high metal	10% increase in hole dia.	Ream hole - break edges
Retainer Rings			
1. Cracks	None permitted	Not repairable	Replace
* 2. Nicks, Scratches	None permitted	Any number up to .003" deep	Blend & polish - Break edges
3. Cuts	None permitted	Any number up to .003" deep - no more than 3/inch	Blend into parent metal- Break edges, polish
4. Dents	Any number up to .030" deep - no sharp corner, high metal	Non-repairable, except radius edges, break corners	Replace & refer to G.E.
Blades Except Dovetail & Tip Tang			
1. Cracks	None permitted	Non repairable	Replace
* 2. Nicks, Scratches	None permitted	a) Airfoil - any number up to 3 mils deep, 1/2" long.	a) Blend & polish. Polish must be longitudinal.
* 3. Cuts - Leading edge and Trailing edge	None permitted	Any number (1" from tang, 1/2" from D/T) .030" deep on LE & TE - no more than 3/linear inch	Blend, break edges, polish
Cuts within 1" tang, 1/2" dovetail	None permitted	Non repairable	Refer to G.E.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
4. Cuts - Convex & Concave Surface	None permitted	Non repairable	Replace
Blade Dovetail			
1. Cracks	None permitted	Non repairable	Replace
2. Nicks, Scratches (Profile)	None permitted	Any number up to .005" deep	Polish & radius edge
3. Nicks, Scratches Pressure Face	None permitted	Non repairable	Replace
4. Dents, Cuts	None permitted	Non repairable	Replace
5. Aquadag	Surface must be covered	Pressure face must be covered	Replace per Spec.
6. Fretting	None permitted	Not repairable	Refer to G.E.
Blade Tip Tang			
1. Cracks	None permitted	Not repairable	Replace
2. Nicks & Scratches	None permitted	Up to .005" deep around edge of tang.	Polish
3. Nicks, Scratches Face of Tang	None permitted	Non repairable without new shot peen	Refer to G.E.
4. Edge of Tang Hole Nicks, Scratches	None permitted	Non repairable without new shot peen	Refer to G.E.
5. Face of Tang Fretting	None permitted	Non repairable without new shot peen	Refer to G.E.
6. Hole Damage, Fretting, Nicks, Scratches	None permitted	Non repairable	Refer to G.E.
7. Hole Damage, Deformation	Top of hole 1/16 wide .003"-.005" deep, no high metal, sharp edges	Not repairable	Refer to G.E.

TABLE 7.2 Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
<u>Torque Band</u>			
1. Cracks	None permitted	Non repairable	Replace
* 2. Dents, Nicks, Scratches	None permitted	Any amount up to .003" deep	Polish, break sharp edges
3. Hole Damage	None permitted	10% increase in hole dia.	Ream hole - break edges
4. Missing or Damaged Grommets	None permitted	Not repairable	Replace
5. Buckles	None permitted	Not repairable	Refer to Engr.
6. Fretting	Any amount .001" depth	.001" depth	Refer to G.E.
<u>Torque Band Bolts</u>			
1. Cracks, Nicks, Thread Damage	None permitted	Not repairable	Replace
2. Burrs or Damaged Heads	Any amount as long as it will take wrench	Not repairable	Replace
<u>Blade-Carrier Bolts</u>			
1. Cracks	Not permitted	Not repairable	Replace (same size)
2. Nicks, Scratches on Shank	Not permitted	Not repairable	Replace (same size)
3. Deformation	Up to .001" bow across entire length	Not repairable	Replace
4. Thread Damage	No go gage	No go gage	Replace
5. Head Damage	Take torque wrench	Torque wrench	Replace
<u>Blade Carrier Nuts</u>			
1. Cracks	None permitted	Not repairable	Replace

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
2. Locking Action (Torque)	No go gage on nut Spec.	No go gage on Spec.	Replace
<u>Turbine Sectors</u>			
<u>Seal</u>			
1. Cracks (Parent Mtl.) Except Seal Lip	None permitted None permitted	Not repairable 1 inch seal length	Replace whole carrier Stop drill (.060" drill)
* 2. Rubs	Rub indications up to .030" depth	Rub indications .030" - .050"	Blend, polish and break sharp edges
* 3. Nicks, Scratches	Any amount up to .003" depth	Any amount up to .003" depth	Blend, polish and break sharp edges
* 4. Dents (lip)	Up to .050" - not sharp or kinked	Up to .050" - not sharp or kinked	Refer to G.E.
5. Seal-Carrier Braze Cracks	Not permitted	Not repairable	Replace
6. Hole Damage Except Cracks	Any amount - not high metal	No high metal - 10% hole diameter	a) Polish high metal b) Remove locknut and rivet, ream hole, break edges, replace nuts.
7. Rivets Missing or Cracked	Not permitted	Not permitted	Replace rivets
8. Locknuts Locking Action (Torque)	No go gage on nut Spec.	No go gage on nut Spec.	Replace
<u>Carrier</u>			
1. Cracks	Not permitted	Non repairable	Replace
2. Deformation (Side Rails)	Not permitted	Non repairable	Refer to G.E.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
* 3. Nicks, Scratches	Any amount .001"-.003" depth	Any amount up to .003" depth	Replace
4. Hole Damage	Not permitted	Open hole to maximum pin diameter in blade	Ream hole, radius edges
5. Carrier/Bucket Braze Cracks	Not permitted	Non repairable	Replace
6. Braze Oxidation	Not permitted	Non repairable	Refer to G.E.
7. Dents	Not permitted except outer side rail flange - .030" deep not sharp or kinked	Non repairable	Refer to G.E.
<u>Buckets</u>			
1. Cracks and Cuts	a) Not permitted within 1" of carrier	a) Non repairable	a) Replace
	b) Through parent mat'l .050" long beyond 1" of carrier	b) Non repairable	b) Refer to G.E. for braze repair
2. Bucket/Shroud Braze Cracks	Total accumulated cracks up to 1/4 inch in length	Cracks in braze; torch repair per spec. cracks in parent material not acceptable	Refer to spec. for torch repair - Refer to G.E.

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
Bucket Shroud			
1. Bucket-Shroud Cracks in Parent Material TE Lip	Lip may be completely cracked	Remove lip	Break sharp edges
Rest of Shroud	Not permitted	Not repairable	Refer to G.E.
2. Missing Shrouds	Up to 1/2 shroud may be missing from TE. No two adjacent buckets	Not repairable	Refer to G.E.
3. Shroud Lip Rubs	Any amount up to .030" depth	Any amount up to .100" depth	Blend, polish, break edges
Pitch Fan Rear Frame			
1. Cracks			
A. All sheet metal parts except vanes and sawcuts	1/2 inch	No limit	a) One inch or less drill with .060" holes b) Over one inch in length, weld with Hastelloy W filler material

TABLE 7.2 - Continued

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
B. Vanes	1/8 inch	One inch	a) 1/4 inch or less - stop drill with .060" holes
			b) One inch or less - add .010" stock thickness patch with 1/4 inch overlap and braze with gold-nickel filler material.
* C. Extension of sawcuts			
1. Outer skin and flanges	No limit	No limit	Nichrome strip if necessary to reduce leakage of hot gas
2. Circular box section	1/4 inch	a) 1/2 inch	a) 1/2 inch or less - stop drill with .060" holes
		b) No limit	b) Over 1/2 inch in length - weld with Hastelloy W filler Material
D. All weld joints except above	1/2 inch	a) 1 inch	a) One inch or less-stop drill with .060" holes
		b) No limit	b) Over 1 inch in length weld with Hastelloy W filler material

TABLE 7.2 - Concluded

INSPECT	MAX. SERVICEABLE LIMITS	MAXIMUM REPAIR LIMITS	CORRECTIVE ACTION
E. All braze joints except ends of vanes	1/2 inch	No limit	Braze with gold-nickel filler materials
F. Braze joints at ends of vanes	1/8 inch	No limit	Braze with gold-nickel filler material
2. Nicks and scratches	No limit provided mat'l. thickness not reduced greater than 1/10 mat'l thickness	No limit	a) Less than 1/10 mat'l thickness - blend affected area b) Over 1/10 material thickness - repair same as a crack
3. A. Dents and bulges in sheet metal other than vanes	No limit provided operation or assembly is not affected	Same as Max. Serviceable Limits	Rework to approximate original contours
B. Dents and bulges in vanes	1/8" from original contour	1/4" from original contour	Rework to approximate original contour or fill with gold-nickle braze as required.
Gas Seals			
1. Cracks	1/8" if gas leakage can be tolerated.	No limit	a) 1/4" or less - stop drill with 0.06" dia. holes. Nichrome repair to reduce leakage. b) 1/4" or more - repair weld using Hastelloy W filler materials. Inert gas backup must be provided.

7.10 PERIODIC INSPECTION REQUIREMENTS

1. Pre-Flight:
   a) Check rotor for freedom of movement.
2. Post Flight:
   a) Check rotor for freedom of movement.
   b) Check honeycomb seals for deep or heavy rubs.
   c) Check blade for nicks and dents.
   d) Check bucket airfoils for foreign object damage.
   e) Check exit vanes for foreign object damage.
   f) Check rear frame for excessive cracks at sawcuts.
3. 50 Hour (Recommended)
   a) Remove rear frame and rotor per disassembly instruction.
   b) Visually check and repair per table of repair limits.
   c) Repack bearing.
4. Preservation:
   a) No preservation requirements have been established.
   b) Based on lift fan experience and grease packed bearings have a life of at least 12 months before repacking is required.

7.11 PITCH FAN SERIAL NUMBERS

Sub assemblies and pitch fan assemblies will be assigned serial numbers at initial buildup and this number will be vibro-etched to the following assemblies in the location noted below:

Pitch Fan S/N - Flat at end of minor strut, 45° position
Front Frame S/N - Pad provided at 2 o'clock position on outboard side of frame
Rear Frame S/N - 12 o'clock on bottom flange of outer skirt
Rotor Assembly S/N - On disc between blades #1 and 36
Scrolls S/N - Inlet flange top side

SECTION 8

TESTING AFTER MAINTENANCE OR OVERHAUL

8.1 INTRODUCTION

This section provides instructions for testing of the X-353-5B lift fan system, X-376 pitch fan and J85-GE-5A or B engine equipt with firewall and diverter valve when installed in the XV-5A aircraft. The test procedures described include the following:

a. J85-GE-5 calibration runs to incorporate rigging changes as required for increased stall margin under conditions of reingestion.

b. Pre-start and motoring checks after engine removal and replacement.

c. J85-GE-5 engine functional tests in turbojet mode at idle and top speed.

d. X-376 and X-353-5B functional tests and trim adjustments.

NOTE

> Instructions in this manual pertaining to the J85-GE-5 engine are for reference only and are superceded by applicable J85-GE-5 manuals and instructions.

8.2 J85-GE-5 Engine Calibration Tests

The test procedures described below apply to a functional and calibration test of the engine and diverter valve system. This test should be performed on all engines to be installed in the XV-5A aircraft after any major maintenance or overhaul where fuel or oil lines have been disconnected. Likewise, this test should be performed on all new engine not equipt with the rigging changes as required for increased stall margin.

8.2.1 Preparation for Test

a. The J85-GE-5 engine should have been modified for the XV-5A by installation of the fire wall shield over the combustion liner.

b. The diverter valve should be rigged for proper door closure, seal engagement and limit switch operation and installed on the basic engine as per Section IV of this manual.

c. The engine should be fitted with the aircraft furnished fuel flow and oil pressure transmitters.

d. Install the engine-diverter valve system in a calibrated thrust frame capable of measuring thrust levels up to 3000 pounds. This is not a mandatory requirement for test but is desirable for performance evaluation.

e. Install a tail pipe on the straight - through leg of the diverter valve. Either the XV-5A tail pipe or a "slave" tail pipe may be used. The slave tail pipe should contain at least 24" of straight section and terminate in a convergent nozzle of approximately 110 Square Inches with a capability of trimming the area down to 100 Square Inches.

f. Attach a 3000 psi hydraulic source to the diverter valve actuator "Extend" ports, both primary and standby. Route the "Retract" ports to the hydraulic supply reservoir. The seal drain line should be routed to an overboard dump.

CAUTION

Do not apply pressure to the actuator until the diverter valve actuation and linkage has been hand operated through the complete stroke to insure no interferences with the mounting arrangement on other parts.

NOTE

With hydraulic pressure applied to the system, considerable return flow should occur because of a free flow path through the actuator piston orifice that provides for cooling. No appreciable flow should occur out the seal drain line.

g. Attach a standard test type bellmouth and inlet screen to the front flange of the engine.

h. Provide a fuel supply to the main fuel control inlet capable of delivering 3000 pph at 6 to 60 psia.

i. Install a vibration pick-up (typical pick-up is CEC #118) on the forward compressor case flange for measurement of vibration in the vertical plane.

8.2.2 Engine Re-Rigging

Because of the severe reingestion encountered during fan powered flight of the XV-5A while in ground effects, the rigging of the bleed valves of the engine must be modified to provide for increased stall margins with minimum loss in thrust. The following rigging changes should be incorporated in each engine before running the functional checks.

a. Increase the maximum or top speed to 102%. Normally the engine top speed would have been adjusted to near 100%. In anticipation of this increased speed, rotate the maximum speed adjustment 15 clicks clockwise and then 5 clicks counterclockwise. This procedure is required for removing any backlash. Always adjust speed in the decreasing speed direction by increments of at least 5 clicks.

b. Increase the squeeze on the T_2 bellows by 0.020 to 0.025". On J85-GE-5A engines, this is accomplished by turning the Allen head screw on the T_2 sensor cap clockwise 120 degrees (2 flats). On J85-GE-5B engines, remove 0.020 to 0.025" of shims from between the bellows cap and the T_2 aspirator manifold.

c. Set the bleed valves open by 0.050 to 0.060". This is accomplished in the following manner:

- Remove bleed valve rod end clevis pin and loosen the rod end jam nut.
- Extend rod end 3 1/2 turns and reconnect clevis pin.
- Check bleed valves for travel and for similarity of left and right windows.

NOTE

These rigging changes revise the bleed valve schedules to those shown in Figure 8.1 and previous bleed valve schedules for the J85-GE-5A and B engines are not applicable to the XV-5A system.

8.2.3 Instrumentation and Measurements

The following parameters must be recorded during conduct of the engine functional test. Normal aircraft quality instrumentation and meters may be used where applicable, for example, EGT, fuel flow and RPM. The measurements are as follows:

Engine RPM

Engine EGT

Fuel Flow

Compressor Inlet Temperature (screen thermocouples)

Fuel Density

Oil Pressure

#2 Bearing Oil Temperature

Thrust

Bleed Valve Position (full closed).

Engine Front Frame Vibrations

Barometric Pressure at test site.

NOTE

Engine vibration read-out equipment should be fitted with a high pass filter with a cut-off frequency of 70 cps.

8.2.4 Test Procedures

8.2.4.1 Prestart Inspection

a. Check the engine inlet for security of hardware and any foreign materials.

b. If the condition of the engine oil is unknown, drain the oil, check the oil filter and refill.

c. Check accessible fuel, oil, air and electrical lines for security, wear and leaks.

8.2.4.2 Prestart Checks (No Ignition)

a. Connect air impingment start unit (AIS).

b. Turn on fuel boost and hydraulic pressure.

c. Turn on AIS and engine should reach a minimum of 15% RPM in 15 seconds.

d. Check engine for signs of fuel and oil leaks.

e. Turn off AIS and observe engine coast down for unusual noises.

f. Operate the ignition switch to "On" and observe the audible spark discharges.

8.2.4.3 Starting and Check-out.

a. Check that fuel boost and diverter valve hydraulic pressure is on.

b. Connect the AIS and begin motoring the engine.

c. When the engine RPM reaches a minimum 14% RPM, turn on the ignition and advance the throttle to the "idle" position.

NOTE

Observe instruments during start. Normal light-off is 5 seconds. Normal EGT is 600-800°C, fuel flow is 200-350 pph and oil pressure is 5-20 psig.

CAUTION

If light-off does not occur before fuel flow reaches 350 pph, chop throttle to "OFF". If EGT reaches 900°C, chop throttle. In both cases turn off the ignition system.

d. When a normal start occurs, at 40% RPM shut off the ignition and disconnect the AIS.

NOTE

At Idle, engine RPM should be maintained above 46.5%. If lower, slightly advance throttle to give 48 - 50% RPM.

e. After the engine has stabilized at idle, perform check of engine for signs of leakage and security of parts, and observe following instrument values:

RPM ------------------	48% ± 1 1/2%
EGT ------------------	400 - 600°C
Fuel Flow -----------	400 - 600 pph
Oil Pressure --------	5 - 20 psig
Engine Vibs ---------	less than 3 mils.

f. Advance throttle slowly to "Mil" and check the following instruments during the acceleration for normal indications:

RPM ------------------	102% ± 1/2%
EGT ------------------	670 - 685°C
Fuel Flow -----------	2000 - 3000 pph
Oil Pressure --------	20 - 50 psig
Engine Vibs ---------	less than 3 mils.

g. If engine is within normal operating limits as given in Figure 8.2, proceed with test omitting Par. 8.2.4.4.

8.2.4.4 Speed and EGT Adjustments

a. Because speed - EGT relationships are inter-related, it is preferable to adjust EGT at maximum speed, then adjust military speed and then idle speed.

b. With the engine operating at maximum throttle setting, EGT of 680°C or 102% ± 1/2% RPM (whichever occurs first), take a complete reading of the engine parameters. Then shut down engine and perform the nozzle area adjustments necessary to bring the EGT to within limits of 670 to 685°C. Figure 8.2 is provided as a guide for adjusting EGT to within limits. Figure 8.2a shows the area of "Mice" required in square inches when adjusting the slave tail pipe area. Figure 8.2b shows the radial distance each of the trim tabs around the periphery of the XV-5A nozzle which must be moved for a comparable area change.

c. After the nozzle area has been retrimmed, restart the engine and accelerate again to maximum throttle setting and observe engine RPM.

CAUTION

Do not exceed 104% RPM during these tests. If full throttle is greater than 104% RPM, reduce engine RPM to "idle" and perform appropriate adjustment of maximum RPM as described below.

All speed adjustments must be made at idle speed.

d. Based on the previous tests determine the number of clicks required on the "mil" speed adjust to bring the RPM into limits. About 6 clicks to the "mil" speed adjustment is equivalent to 1% engine speed. A clockwise rotation will cause an increase in maximum speed.

NOTE

Always adjust speed in a decreasing direction in increments of at least 5 clicks. For example, to decrease speed on click increase 4 clicks then decrease 5 clicks.

e. Advance the throttle to maximum and continue speed adjustments until RPM is 102% ± 1/2%.

f. With the throttle at idle, adjust the "idle" speed control to 48% ± 1%. About three clicks of the "idle" speed adjustment is equivalent to 1% engine RPM change.

CAUTION

Engine RPM should be maintained about 46.5% during this adjustment.

8.2.4.5 Calibration Run

This phase of the test is to verify performance of the re-rigged engine by observing bleed-valve closing schedule, EGT, fuel flow and thrust, if applicable.

NOTE

These tests should be performed only with a compressor inlet temperature less than 70°F and a wind speed of less than 5 knots, if tested in an outdoor facility.

a. Accelerate the engine slowly from "idle" to mil" and observe the engine RPM at which the bleed valve reaches the full closed position.

b. After the valve is fully closed and the engine is at 102% ± 1/2% RPM, slowly decelerate the engine to "idle" and observe the speed at which the bleed valve begins to open.

NOTE

Using these engine speeds and measured compressor inlet temperature, the bleed valve closing schedule must be within the limits shown in Figure 8.1. Previous J85-GE-5 bleed valve schedules are no longer applicable.

c. If bleed valve is out of specified limits, readjust the schedule by lengthening or shortening the feed-back cable.

NOTE

Increasing the length of the feed-back cable will increase the speed at which the bleed valves reach the full closed position.

d. After the rigging of the engine has been verified perform the calibration run as follows:

- Adjust the engine speed to 92, 94, 96, 98, 100 and 102% RPM.
- Stabilize for two (2) minutes at each RPM and take a complete reading of all parameters.

e. Following completion of the calibration run, remove and change oil filter.

f. Following replacement of the oil filter, start the engine and perform a slow acceleration to "mil" and back to "idle". Following this run, check the engines for signs of fuel or oil leakage and shut down engines.

8.2.4.6 Performance

Figure 8.3 through 8.5 present normal variation of EGT, fuel flow and thrust for the re-rigged engines. These parameters are presented as values corrected to standard condition of temperature and pressure. The variation of these correction factors with barametric pressure and compressor temperature are shown in Figure 8.6 and 8.7.

NOTE

These curves are presented for reference only and are not intended to define guarantee limits of performance.

8.3 System Functional and Performance Tests

These test procedures describe the methods applicable to performing a functional checkout of the complete propulsion system installed in the XV-5A aircraft. Part of or all of the following tests should be performed after the following:

a. Engine-diverter valve removal or replacement.

b. X-353-5B wing fan removal for overhaul or replacement.

c. X-376 pitch fan removal for overhaul or replacement.

8.3.1 Preparation for Test

a. Prior to performing the following function tests, the complete propulsion system should be installed in the XV-5A aircraft.

b. All aircraft panels and structures should be installed in place with the exception of the engine bay cover.

c. The aircraft should be tied down in preparation for fan and engine running.

8.3.2 Instrumentation and Measurements

a. For these tests, all engine and fan cockpit instruments shall be in working order and within normal operational calibration limits.

b. The aircraft instrumentation (PCM) system shall be operating and a minimum of the following channels shall be calibrated and functional:

- Engine RPM - Left and right
- Wing Fan RPM - Left and right
- Pitch Fan RPM
- Engine EGT - Left and right
- Engine Fuel Flow - Left and right
- Bleed Valve Position - Left and right
- Vector Command Angle
- Exit Louver Positions - all four
- Pitch Fan Thrust Modulator Position
- Longitudinal and Lateral Stick Position
- Collective Stick Position
- Rudder Pedal Position
- Wing Fan and Pitch Fan Inlet Temperatures
- Engine Inlet Temperature - Left and right

c. In addition to the previously listed aircraft instrumentation, the following measurements must be taken either by remote instruments or any other acceptable method, for example, telemetered.

- Wing Fan Hub Axial Vibration - Left and right
- Pitch Fan Hub Axial Vibration
- Engine Compressor Front Frame Vibration - Left and right.

Section 8.2.3 and 8.2.4 describe the equipment necessary for measurement of the engine vibrations. The fan vibrations must be measured using CEC #122A vibration pickups installed in the fan bullet noses. Vibration pickup output should be measured on a standard vibration meter calibrated in peak to peak displacements in mils.

NOTE

All vibration meters used for fan vibration measurements must be fitted with a high-pass filter with a cut-off frequency of 30 cps.

8.3.3 Functional Tests

8.3.31 Prestart Inspection

a. Check the engine inlets and exits for security of hardware and any foreign materials.

b. Check accessible fuel, oil, air and electrical lines for security, wear or leaks.

c. The aircraft should be in the pre-conversion configuration and check the fan inlets and exits for security of hardware and foreign materials. Check the wing fan hub area for signs of hydraulic fluid leakage.

8.3.3.2 Prestart Checks

NOTE

These tests should be performed only after engine removal and replacement or maintenance involving controls or plumbing.

Fan replacement does not require these tests to be performed.

The engine bay cover shall not be installed for these tests.

a. Connect the AIS unit to the starter connection for the #1 engine.

b. Connect the remote electrical power supply to the aircraft.

NOTE

Consult the applicable aircraft T.O.'s for aircraft inspections and preparation for operation on both the turbojet and fan modes.

c. Check that the throttles are at "off", fuel boost pumps "on", ignition "off" and fuel shut-off valves "on".

d. Turn "on" AIS and engine #1 should reach a minimum of 15% RPM in 15 seconds. Listen for smooth engine acceleration. Observe normal indication of RPM, hydraulic pressure and oil pressure.

e. Check engine for signs of fuel and oil leaks.

f. Turn AIS supply "off" and observe smooth coast down free of unusual noises.

g. Repeat the above items for engine #2.

h. After the above pre-start checks, check each engine ignition system by turning "on" the ignition and observe the audible ignitor discharge.

8.3.3.3 Engine Run Checkout

NOTE

For these tests the engine bay cover shall not be installed on the aircraft.

a. Connect the AIS to engine #1 connection and remote electrical supply to the aircraft.

b. Check that the throttles are "off" fuel boost pumps "on", fuel shut-off valves "on" and ignition "off".

c. Begin motoring engine #1 and when the RPM reaches a minimum of 14% RPM, turn on the ignition and advance the throttle to the "idle" position.

NOTE

Observe instruments during start. Normal light-off is 5 seconds. Normal EGT is 600 - 800°C. Fuel flow is 200 - 350 pph and oil pressure is 5 - 20 psig.

CAUTION

If light-off does not occur before fuel flow reaches 350 pph, chop throttle. If EGT reaches 900°C, chop throttle. In both cases, turn off the ignition system.

If a false start occurs, that is no ignition, shut off the throttles and motor the engine on AIS for about 30 seconds. Observe that no appreciable fuel drainage is occurring from the scroll fuel drain lines.

d. When a normal start occurs, at 40% RPM shut off the ignition and the AIS unit.

e. With engines at idle RPM (48% ± 1.5%) inspect the engine bay area for signs of fuel, oil or hot gas leakage.

f. After the engine has stabilized, clear the area and slowly accelerate the engine to "mil" RPM of 102% ± 1/2%.

NOTE

During accel observe normal conditions as follows:

RPM --------------- 102% ± 1/2%
EGT --------------- 670 - 685°C
Fuel Flow --------- 2000 - 3000 pph
Oil Pressure ----- 20 - 50 psig
Engine Vibs ------ 4 mils steady, peaking 5 mils.

g. If all indications are normal, allow engine to stabilize for one minute at maximum power setting and then retard throttle to "idle" and allow to stabilize for 30 seconds.

NOTE

If either RPM or EGT exceeds limit at full throttle, reduce power setting to limiting value and maintain power setting as above.

h. Chop throttles to "off" and observe engine coast down for unusual noises or rubbing.

NOTE

Prior to shutting off engine, start AIS unit and connect to aircraft. Characteristics of the XV-5A aircraft result in excessive engine soak-back temperatures after shut down, so be prepared to motor engine. When EGT indication reaches 250°C, turn on AIS to engine and motor for 10 - 20 seconds until EGT reduces to 100°C or lower.

i. Repeat the above engine check-out from the #2 engine.

NOTE

During the previous engine runs take a complete reading of the engine parameters at the maximum power setting. These readings include fuel flow, RPM and EGT. Based on these readings make adjustments of maximum RPM and EGT as per Par. 8.2.4 (a) through (e).

Also at the "idle" power setting observe idle RPM and make appropriate adjustments as per Par. 8.2.4.4 (f).

8.3.3.4 Fan Check-out

a. This part of the test program is performed to check the following:

- Final engine RPM and EGT trim setting at "mil" and "idle" throttle settings in the turbojet mode.
- Functional performance of the X-353-5B and X-376 fan systems.
- Engine EGT trim and fan system balance in the fan mode.

NOTE

For these tests, the wind velocity must be less than 5 knots. This restriction is required because of wind effects on fan speeds.

Consult the applicable aircraft T.O.'s for adequate pre-run inspections and operation of the aircraft systems.

b. Prior to beginning tests, the aircraft shall be completely assembled with all access panels and covers installed. The aircraft should be in the pre-conversion mode and tied down on an outside ramp.

CAUTION

During the following tests the aircraft will be subjected to operation in the fan mode for sustained periods of time. This condition could very easily result in overtemperaturing of the equipment located in the main landing gear wheel well area. It is desirable to provide test type doors for closing the wheel well area during these tests. However, if this is not the case, it is mandatory that thermocouples for monotoring structure and air temperatures be provided in this area, and a continual recording read out instrument be provided. Consult applicable aircraft T.O.'s for limits during the test operations.

c. Check the engine and fan inlets and exits for security of hardware and any foreign objects before beginning the tests.

CAUTION

Clear the area around the aircraft (approximately 50 feet radius) of all loose and unanchored hardware and equipment. Check the test site area for foreign objects that could be picked up by the fans and engines.

d. Start the left (#1) engine as per Par. 8.3.3 and set engine at "idle" RPM.

NOTE

Before proceeding with the following tests verify that PCM instrumentation is "on" and operating. With only one engine operating in the aircraft, the electrical load distribution system will prohibit turning on the instrumentation system. Therefore, during these tests, the external power plug must remain attached and supplying power to the aircraft.

CAUTION

Because of the strong air velocities around the aircraft while operating in the fan mode, the external receptacle must be securely fastened in place and the lead wires securely anchored to prevent "whipping" while operating the systems.

e. With the aircraft in the "Jet" mode, slowly accelerate the engine to "mil" and observe the following normal indications:

RPM ----------------- 102% ± 1/2%
EGT ----------------- 670 - 685°C
Fuel Flow ----------- 2000 - 3000 pph
Oil Pressure -------- 20 - 50 psig
Engine Vibs --------- 4 mils steady, peaking 5 mils.

If either EGT or RPM exceeds the maximum limits, set the engine speed to limits and record all engine parameters.

f. Reduce engine RPM to 70% and operate the conversion switch to the "Fan" position. The aircraft should convert from the turbojet to the fan mode of flight. Observe that the instrumentation indications are as follows:

Engine RPM ---------- 70% ± 1%
Engine EGT ---------- 400 - 500°C
Fuel Flow ----------- 700 - 900 pph
Oil Pressure -------- 10 - 35 psig
Engine Vibs --------- 3 mils steady, peaking 4 mils
Wing Fan RPM -------- 35 - 45%
Pitch Fan RPM ------- 45 - 55%
Fan Vibration ------- 5 mils steady, peaking 10 mils.

NOTE

Consult applicable aircraft T.O.'s for normal conversion checks and sequences of the aircraft for operation in the two flight modes.

CAUTION

While in the "fan" mode, minimum engine RPM is 70% as compared to "idle" of 48%. RPM should never be reduced to below 70% in the "fan" mode.

g. Reduce the vector command angle to "zero" degrees and trim the longitudinal stick to about 3/4 nose down.

h. Slowly accelerate the engine to "mil" and continually monitor that the instruments are within the following limits. Total acceleration time should not be less than 10 seconds.

Engine RPM -------------	102% ± 1/2%
Engine EGT -------------	670 - 685°C
Fuel Flow --------------	2000 - 3000 pph
Oil Pressure -----------	20 - 50 psig
Engine Vibs ------------	4 mils steady
Wing Fan RPM -----------	70 - 80%
Pitch Fan RPM ----------	80 - 90%
Fan Vibs ---------------	5 mils steady, peaking 10 mils

NOTE

During this acceleration of the engine aircraft PCM, instrumentation must be "on" and operating.

i. With the engine at maximum RPM of 102.5% or maximum EGT of 685°C, stabilize for 5 seconds and take a complete reading of the engine parameters and fan RPM's.

j. With the engine at the above maximum power setting, increase vector command at the maximum rate to the full aft vector position.

k. Decelerate the engine to 70% RPM and convert the aircraft to the "Jet" mode.

CAUTION

During the above tests as well as any other tests in the fan mode in the presence of the ground, the engines may be subjected to severe levels of reingestion. This may result in EGT levels in excess of the normal operation limits. During these tests, the EGT should not be allowed to exceed 700°C (continuous).

l. Shut off the #1 engine, connect the AIS to that engine and be prepared to motor the engine when the EGT exceeds 250°C.

m. Repeat the above procedure described in Paragraphs (d) through (l) for the right (#2) engine.

NOTE

The fan speed readings taken at full power settings serve as a basis for checking power distribution balance of the gas generator output to the two wing fans. For these results, the following limits apply:

Fan RPM's (left and Right) must be equal within 1/2%.

Engine RPM should be 101.5% to 102.5% at an EGT of 670°C to 685°C.

If these limits are not met, immediately retrim the fan scrolls according to the procedures in Par. 8.3.4. If within limits, proceed with the following tests.

n. Start both engines as per Par. 8.3.3 and set engines at "idle" RPM.

NOTE

Before proceeding with the following tests verify that PCM instrumentation is "on" and operating.

o. With the aircraft in the "CTOL" mode, slowly accelerate both engines to "mil" and hold throttles at power settings of 90, 92, 94, 96, 98, 100 and 102%. The engines should be allowed to stabilize for 10 seconds at each speed setting, and a complete reading of cockpit instrumentation taken and recorded.

NOTE

During these tests at maximum speed, observe normal instrumentation indications as follows:

RPM (max.) ------ 102% ± 1/2%
EGT ------------- 670 - 685°C
Fuel Flow ------- 2000 - 3000 pph
Oil Pressure ---- 20 - 50 psig
Engine Vibs ----- 4 mils steady, peaking 5 mils.

If EGT or RPM's are out of limits, adjust using previous methods.

p. Reduce power setting to 70% RPM and change aircraft mode from "Pre-Conversion" to "Conventional". Rapidly accelerate engines to "mil" and observe fan cavity temperature indicators in the cockpit. Hold power setting at "mil" for 20 seconds and observe that fan cavity temperatures are still within limit of 120°C.

NOTE

These tests are intended to check amount of diverter valve leakage flow in the turbojet mode as indicated by fan cavity temperatures.

CAUTION

In the event fan cavity temperatures exceed the 120°C limit, immediately reduce engines to 70% RPM and put aircraft into the "Pre-Conversion" configuration. Observe that fan cavity temperatures drop to within limits. If not, shut down both engines and investigate causes of overheating.

q. With the aircraft in the "Pre-Conversion" configuration and engines at 70% RPM, operate the conversion switch to the "Fan" position. Aircraft should convert from the turbojet to the fan mode of flight. Observe that instrumentation indications are as follows:

Engine RPM ---------	70% ± 1%
Engine EGT ---------	400 - 500°C
Fuel Flow ----------	700 - 900 pph
Oil Pressure ------	10 - 35 psig
Engine Vibs ------	3 mils steady, peaking 4 mils
Wing Fan RPM -----	40 - 50%
Pitch Fan RPM ----	45 - 55%
Fan Vibration ----	5 mils steady, peaking 10 mils

NOTE

Consult applicable aircraft T.O.'s for normal conversion sequence of the aircraft between the two flight modes.

CAUTION

While in the "fan" mode, minimum engine RPM is 70% as compared to normal "idle" in the "Jet" mode of 48% RPM.

r. Reduce vector command angle to "zero" degrees and trim the longitudinal stick position to about 3/4 nose down position.

s. Slowly increase engine RPM to maximum and continually observe that instruments are within the following limits. Total acceleration time should not be less than 10 seconds.

Engine RPM ----------	102% ± 1/2%
Engine EGT ----------	670 - 685°C
Fuel Flow ----------	2000 - 3000 pph
Oil Pressure --------	20 - 50 psig
Engine Vibs ---------	4 mils steady, peaking 5 mils
Wing Fan RPM --------	100%
Pitch Fan RPM -------	110%
Fan Vibs ------------	5 mils steady, peaking 10 mils.

NOTE

During the acceleration of engines, aircraft PCM instrumentation system should be "on" and operating.

t. With the engine at maximum RPM of 102.5% or maximum EGT of 685°C, stabilize for 10 seconds and take a complete reading of the cockpit instruments.

NOTE

This reading will serve as the basis for checking engine trim in the "fan" mode. Operating limits that should be observed are as follows:

Fan RPM's (left and right) should be equal to within 1/2%.

Engine RPM should be 101.5 to 102.5% at an EGT of 670 to 685°C.

If system is within these limits, proceed with the following tests. If out of limits, retrim the fan system using methods in Par. 8.3.4 and repeat the preceding tests.

u. With the engines at maximum power, perform the following control system excursions in the sequence as shown.

Collective Stick	Longitudinal Stick	Lateral Stick	Rudder Pedal
100%	75% Fwd	Neut.	Neut.
0%	75% Fwd	Neut.	Neut.
0%	50% Aft	Neut.	Neut.
0%	50% Aft	100% Left	Neut.
0%	50% Aft	100% Left	100% Nose Right
0%	Neut.	100% Left	100% Nose Right
100%	Neut.	Neut.	Neut.

v. With the controls located in the positions as at the end of the above set of control excursions, increase the vector command angle at maximum rate to the full aft vector position.

NOTE

Tests in Par. "u" and "v" are intended to demonstrate the stall free operation of the engines as well as an observation of fan performance and louver motors during full throws of the aircraft control system.

CAUTION

During the above tests in Par. "u" and "v", the engine will be subjected to conditions of severe reingestion. This may result in EGT's above normal operating limits. During these tests, the EGT should not be allowed to exce[illegible]00°C (continuous).

During the vector excursions in Par. "v", there is a possibility of wing fan overspeed at the high vector angles. During this test, the wing fan RPM should be monitored carefully on the cockpit dial and engine power should be reduced when the fan RPM reaches 101%, and the tests continued at the maximum possible power setting.

w. Immediately on reaching full excursion of the vector command angle, decrease engine RPM to 70% and divert the aircraft to the "Jet" mode.

x. Allow approximately one (1) minute for the aircraft systems to stabilize and cool down then shut off both engines. Observe the engine coast down for unusual noises.

y. Connect the AIS to the aircraft starter connections and be prepared to motor the engine when the soak-back temperatures reach 250°C.

8.3.4 Trim Adjustments

The following discussion presents the procedures and adjustments that should be used when retrimming the fan systems to produced rated engine performance with the two wing fan speeds trimmed to equal RPM's.

a. The data taken during tests described in Par. 8.3.3.4 (i) and (m) are used as a basis for fan trim adjustments. The data required were taken in the fan mode and are as follows:

- Engine RPM (Left and Right)
- EGT (Left and Right)
- Wing Fan RPM (Left and Right)
- Pitch Fan RPM

b. For trimming the engine RPM - EGT relationships in the "Fan" mode, determine the area change required on each engine using the data shown in Figure 8.2. This figure will yield two area changes designated as follows:

ΔA_{TL} - Change in area to yield rated EGT on left engine.

ΔA_{TR} - Change in area to yield rated EGT on right engine.

c. To trim the fan speeds to equal levels, the data shown in Figure 8.8 should be used. This figure shows the incremental area change between the left and right wing fans to bring the fan speeds (left and right) into line. These area values are designated as:

ΔA_{NL} - Change in area for speed balance with left engine running

ΔA_{NR} - Change in area for speed balance with right engine running.

d. Area trim on the wing fans is accomplished by blocking off portions of the fan scroll turbine nozzles. Both the forward and aft scroll arms of each fan contain this adjustment feature. Figure 8.9 shows a schematic of the scroll area trim system. From this data a minimum area trim capability of 0.85 Square Inches exists of the forward scrolls and 0.44 Square Inches on the aft scrolls.

NOTE

In the XV-5A aircraft the left engine feeds both wing fan leading edge or forward scrolls. The right engine feeds both of the aft scrolls.

e. Using the area changes, the required scroll area trims may be calculated

Forward - left fan scroll

$$\Delta A_{FL} = \Delta A_{TL}/2 + \Delta A_{NL}$$

Forward - right fan scroll

$$\Delta A_{FR} = \Delta A_{TL}/2 - \Delta A_{NL}$$

Rear - left fan scroll

$$\Delta A_{RL} = \Delta A_{TR}/2 + \Delta A_{NR}$$

Rear - right fan scroll

$$\Delta A_{RR} = \Delta A_{TR}/2 - \Delta A_{NR}$$

f. The above calculations will yield the required area changes for each of the arms. These areas will not necessarily be an equal multiplier of the area increments of 0.85 and 0.44 Square Inches given in Figure 8.9. The procedure for selecting the nearest setting (notches) is as follows:

- Compute the nozzle increments required for trim to the nearest full notch for each scroll leg.
- Obtain the remaining area that could not be trimmed using full notch increments. This may be an additional area increase or an area decrease.
- Add the areas (remaining) for the Left and Right forward scroll areas together. Take into account whether the area is an increase or a decrease.
- From this value, determine the nearest full increment that is required and apply this value to the left forward scroll arm area trim.
- Repeat the above procedure for the aft or rear scroll arms and apply this trim to the right rear scroll arm area trim.

g. The following calculations demonstrate the methods to be used during calculation of the required area trims.

- Measured Parameters
- Left Engine Run

RPM (engine) ------- 101.0%
EGT --------------- 680°C
Left Fan ---------- 73%
Right Fan --------- 77%

- Since this is the left engine, that feeds the forward scrolls, the adjustments for the forward arms will be obtained.
- From Figure 8.2a obtain ΔA_{TL} for engine RPM of 101% and EGT of 680°C.

$$\Delta A_{TL} = + 1.4 \text{ Sq. In.}$$

- Compute the fan RPM ratio

$$\frac{\text{Left Wing Fan RPM}}{\text{Right Wing Fan RPM}} = \frac{73}{77} = 0.948$$

- From Figure 8.8 obtain ΔA_{NL} (Left engine)

$$\Delta A_{NL} = 3.0$$

- Compute scroll area change

$$\Delta A_{FL} = \Delta A_{TL}/_2 + \Delta A_{NL}$$

$$\Delta A_{FL} = \frac{1.4}{2} + 3.0 = 3.7 \text{ Sq. In. (Forward - left)}$$

$$\Delta A_{FR} = \Delta A_{TL}/_2 - \Delta A_{NL}$$

$$\Delta A_{FR} = \frac{1.4}{2} - 3.0 = 2.3 \text{ Sq. In. (Forward - right)}$$

- Each notch is 0.85 Square Inches for forward scroll arms, therefore

$$\Delta A_{FL} = 3.7/_{0.85} = 4.35 \text{ notches (open)}$$

$$\Delta A_{FR} = 2.3/_{0.85} = -2.70 \text{ notches (close)}$$

- Therefore, use 4 notches (open) on forward - left scroll arm and 3 notches (close) on forward - right scroll arm.
- Repeat this procedure for the right engine system.

8.4 Fan Performance

a. During the performance runs, since there is no measurement of system lifts or thrust, the parameter to be used for fan performance evaluation will be the maximum fan speed capability at a given maximum power setting.

b. Figures 8.10 and 8.11 show the performance limits that apply to the XV-5A propulsion system. The data shown in these figures are:

- Figure 8.10 - Fan speed versus ambient or compressor inlet temperature at maximum power (102% RPM at 680°C).
- Figure 8.11 - Effects of engine RPM and EGT on fan speeds.

NOTE

The above curves are presented for nominal control setting of zero degrees vector command, collective full-up and longitudinal stick about 75% nose down. (minimum reingestion).

Performance comparisons with Figures 8.10 and 8.11 should be based on engine and fan inlet temperatures under conditions of minimum reingestion in the engine inlets.

c. In addition to the following performance checks, the test discribed in Par. 8.3.3.3 (u), although intended to demonstrate stall free operation of the engines, may also serve as a basis for checking louver and pitch fan modulator door rigging under normal loaded conditions.

NOTE

The results of these tests should be compared to the applicable aircraft rigging specifications.

8.5 Operational Limits

8.5.1 J85-GE-5A or B Engine

NOTE

These limits of engine operation are presented here for reference only and are not intended to supersede the applicable J85-GE-5 manuals and instructions.

a. Engine Speeds

Idle Speed -------- 48% ± 1 1/2%
Military Speed --- 102% ± 1/2% (re-rigged for XV-5A)
Overspeed -------- 104% (maximum) Steady state

b. Exhaust Gas Temperatures

Starting --------- 900°C (maximum)
Idle ------------- 400 - 600°C
Military --------- 670 - 685°C

NOTE

Permissible EGT fluctuation is 15°C with temperature not to exceed 685°C.

c. Vibrations

Forward Compressor	4 mils steady state
	5 mils peaking

d. Oil System

Idle Pressure	5 - 20 psig
Military Pressure	20 - 50 psig
Fluctuations	± 2 psig

NOTE

Extreme cold starting may cause excessive oil pressures. Consult applicable engine manuals and instructions for limits.

Oil Temperature

Tank -------------------- 350°F (177°C) Maximum
No. 2 Bearing Scavenge---380°F (193°C) Maximum
No. 3 Bearing Scavenge---380°F (193°C) Maximum

e. Fuel Flow

Starting----------------	200 - 300 pph
	(350 pph Maximum)
Idle ------------------	400 - 600 pph
	(± 25 pph Fluctuation)
Military --------------	2000 - 3000 pph
	(± 50 pph Fluctuation)

8.5.2 X-353-5B Wing Fan

a. Speed ------------------------*100% Maximum Steady State
(103% Maximum at throttle cut-back)

b. Hub Vertical Vibs ------------ 5 mils steady
10 mils peaking

c. Fan Bearing Temperature ------ 350°F Maximum

8.5.3 X-376 Pitch Fan

a. Speed -----------------------*108% Maximum Steady State
(110% Maximum at throttle cut-back)

b. Hub Vertical Vibs ----------- 5 mils steady
10 mils peaking

c. Fan Bearing Link ------------- 350°F Maximum

*Set aircraft fan overspeed warning light to light at maximum steady state speed point.

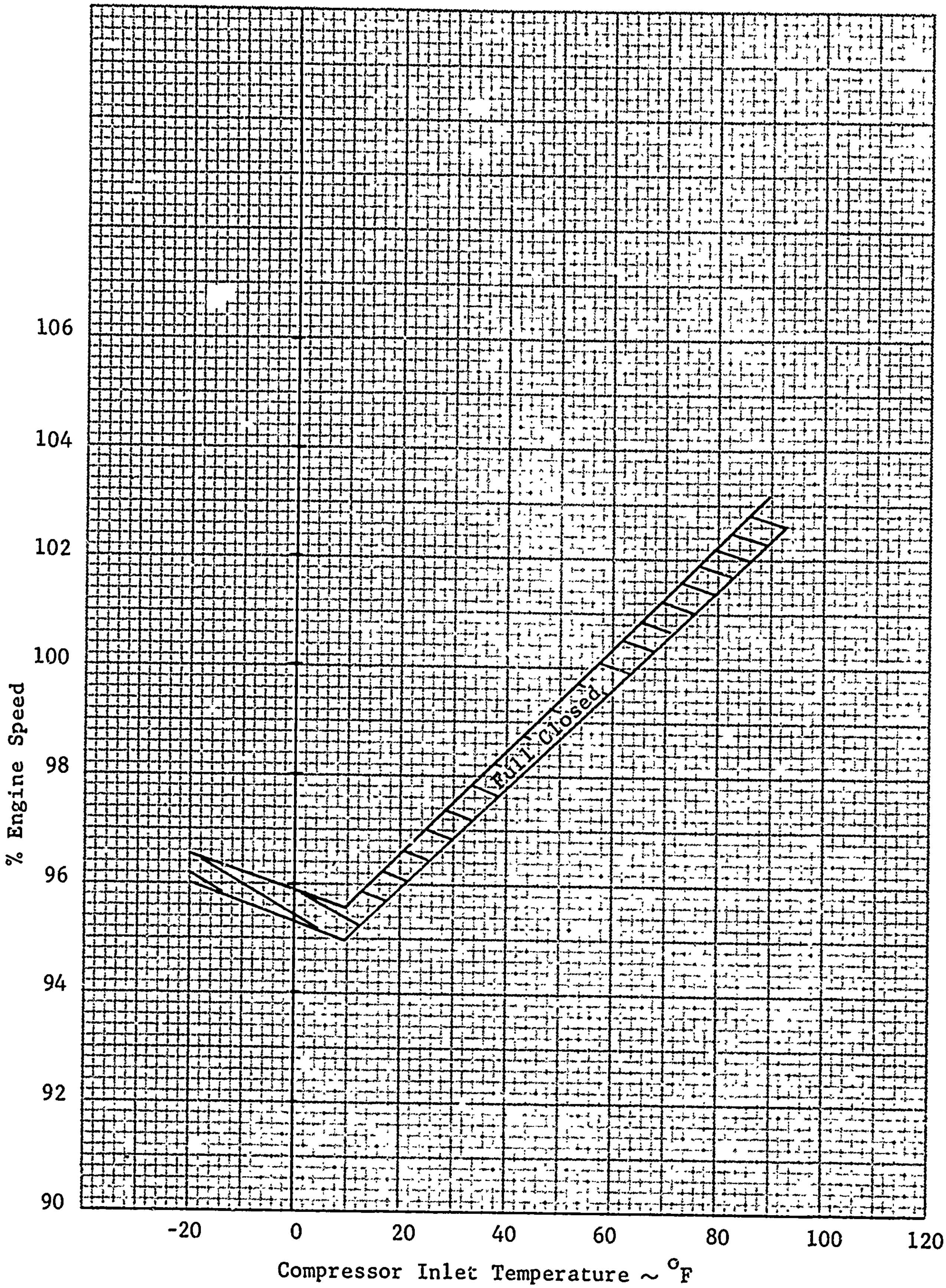


FIGURE 8.1 SPECIAL BLEED VALVE SCHEDULE FOR XV-5A

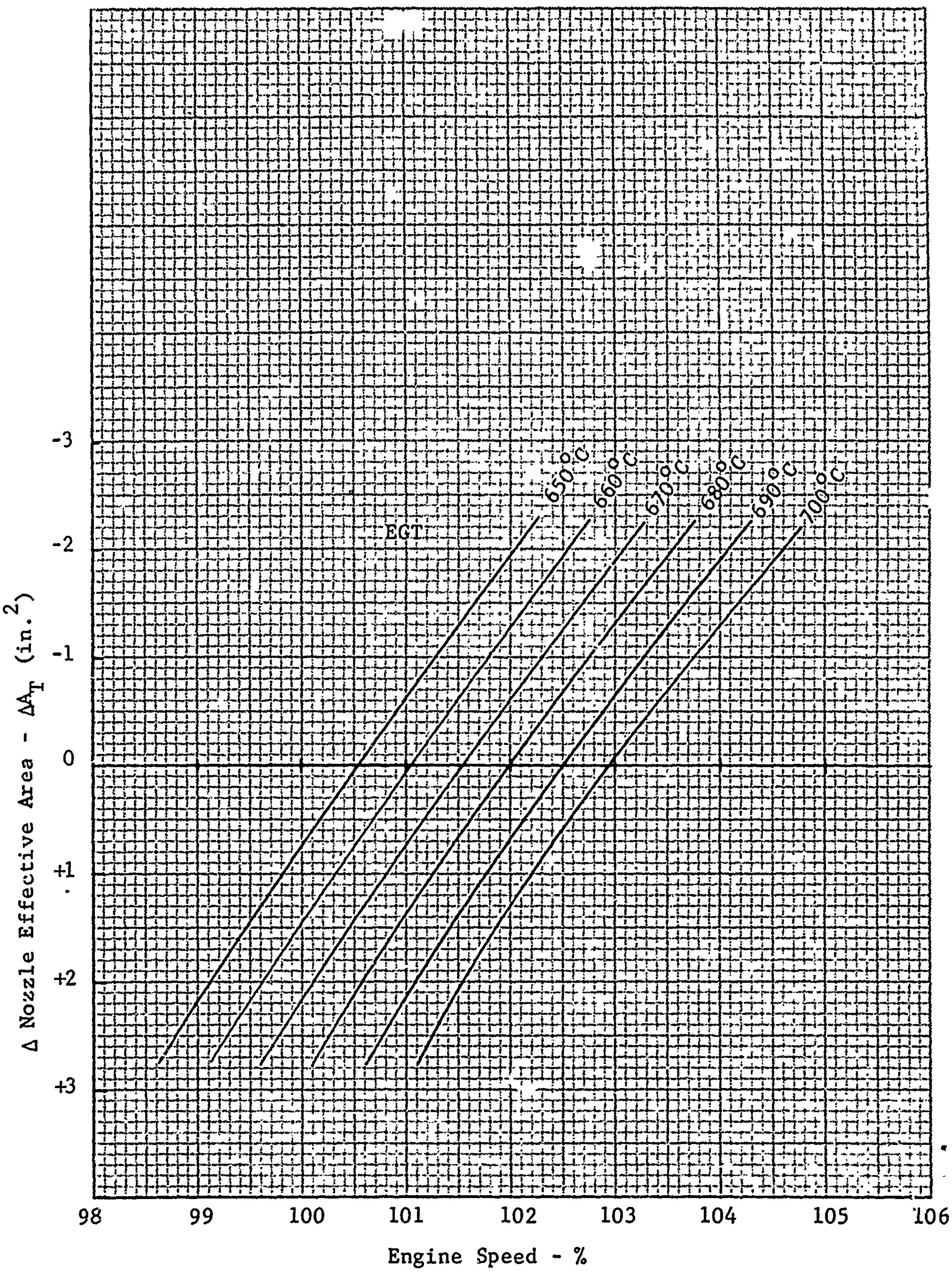


FIGURE 8.2A Δ AREA FOR TRIM VERSUS EGT AND RPM

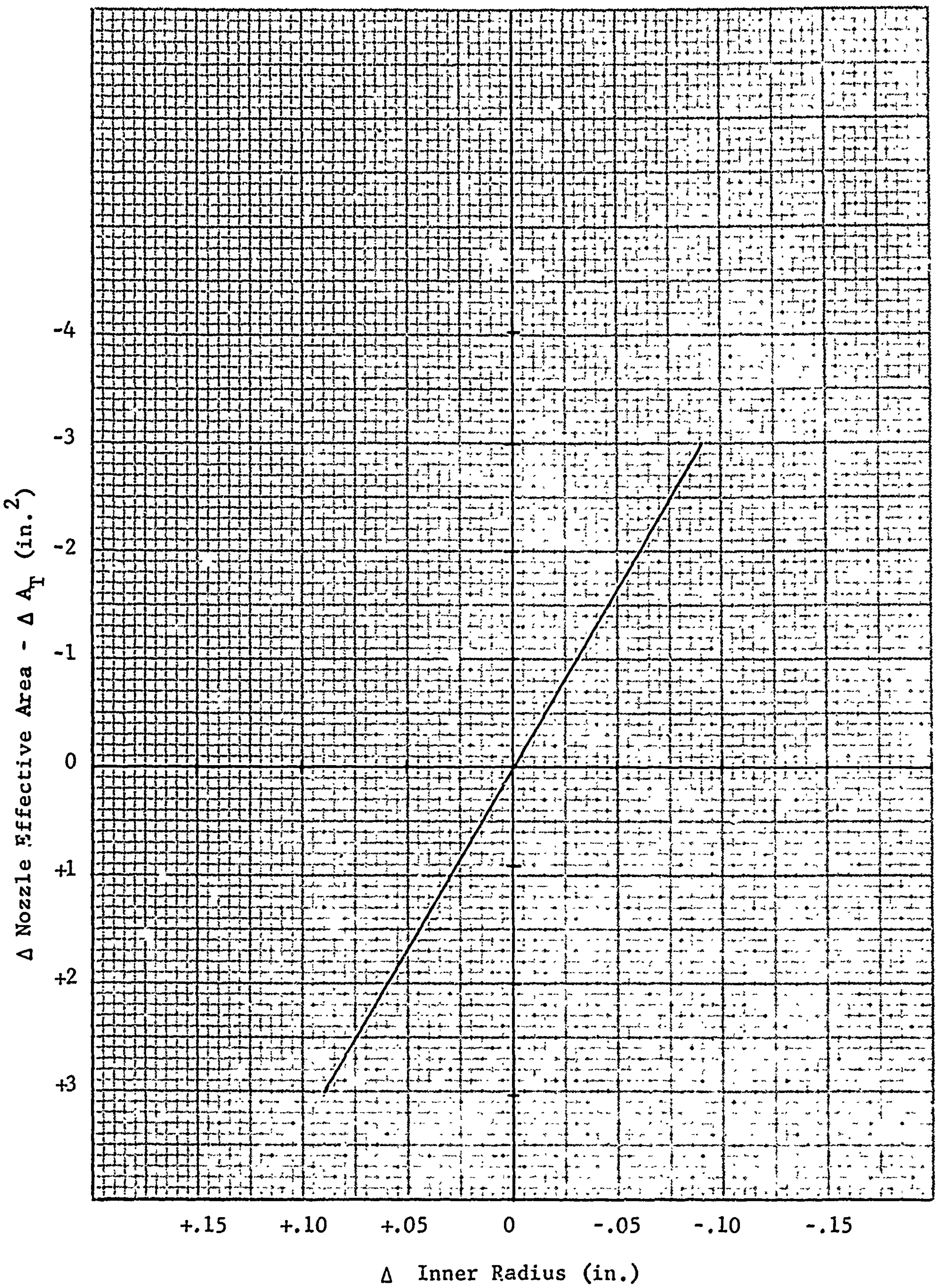


FIGURE 8.2B Δ AREA VERSUS Δ RADIUS FOR TRIM

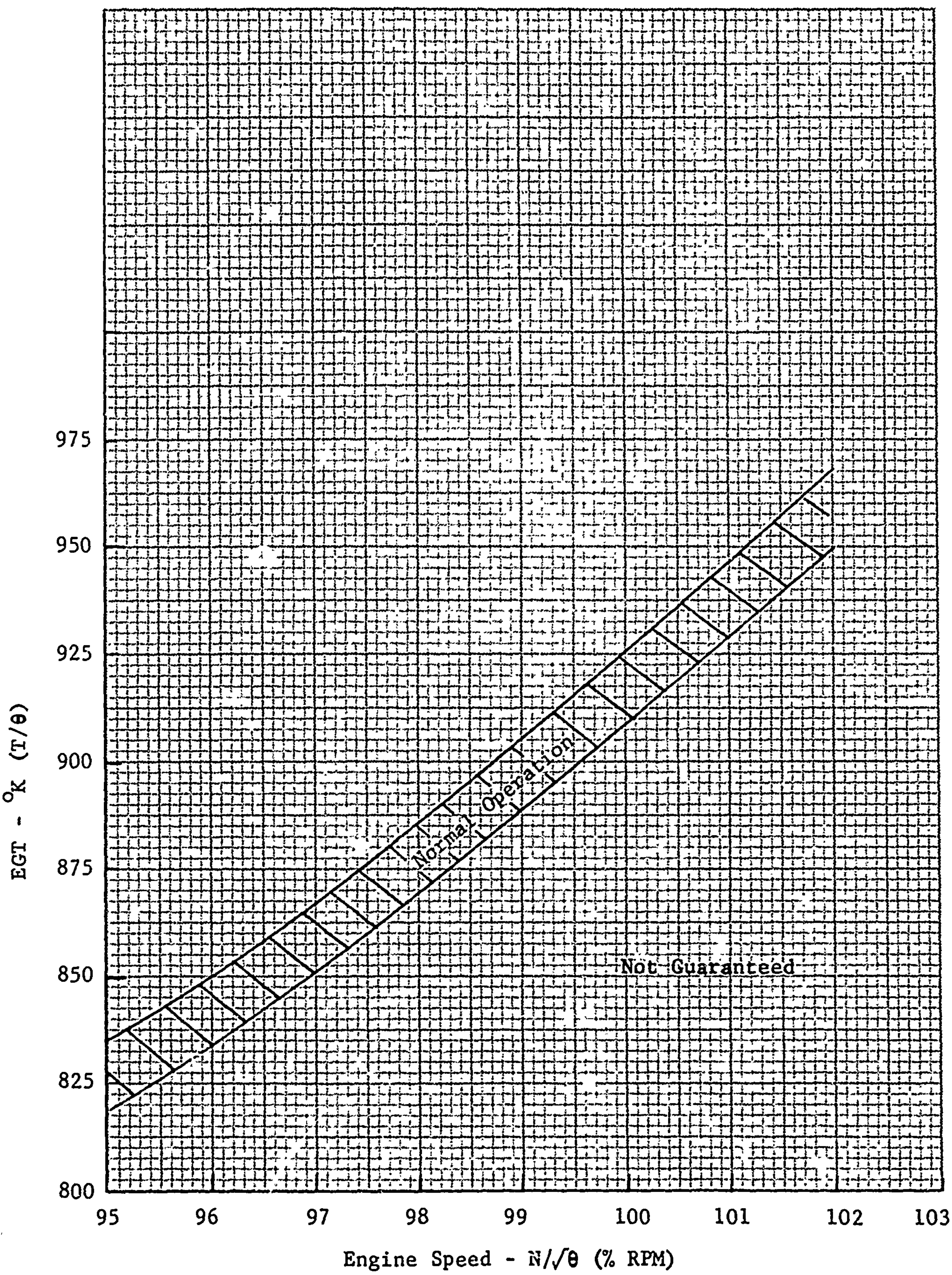


FIGURE 8.3 EGT VERSUS ENGINE SPEED

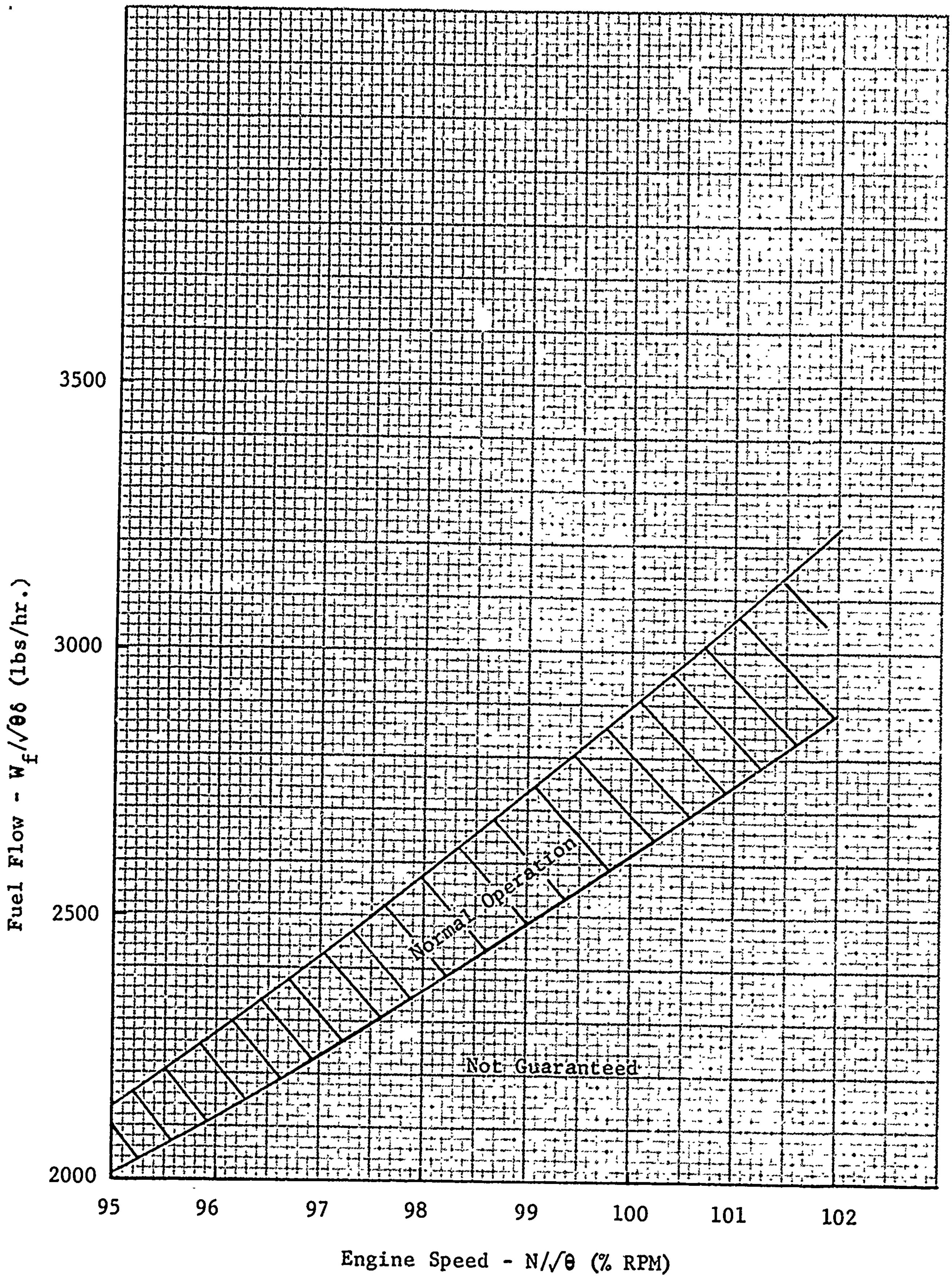


FIGURE 8.4 FULL FLOW VERSUS ENGINE SPEED

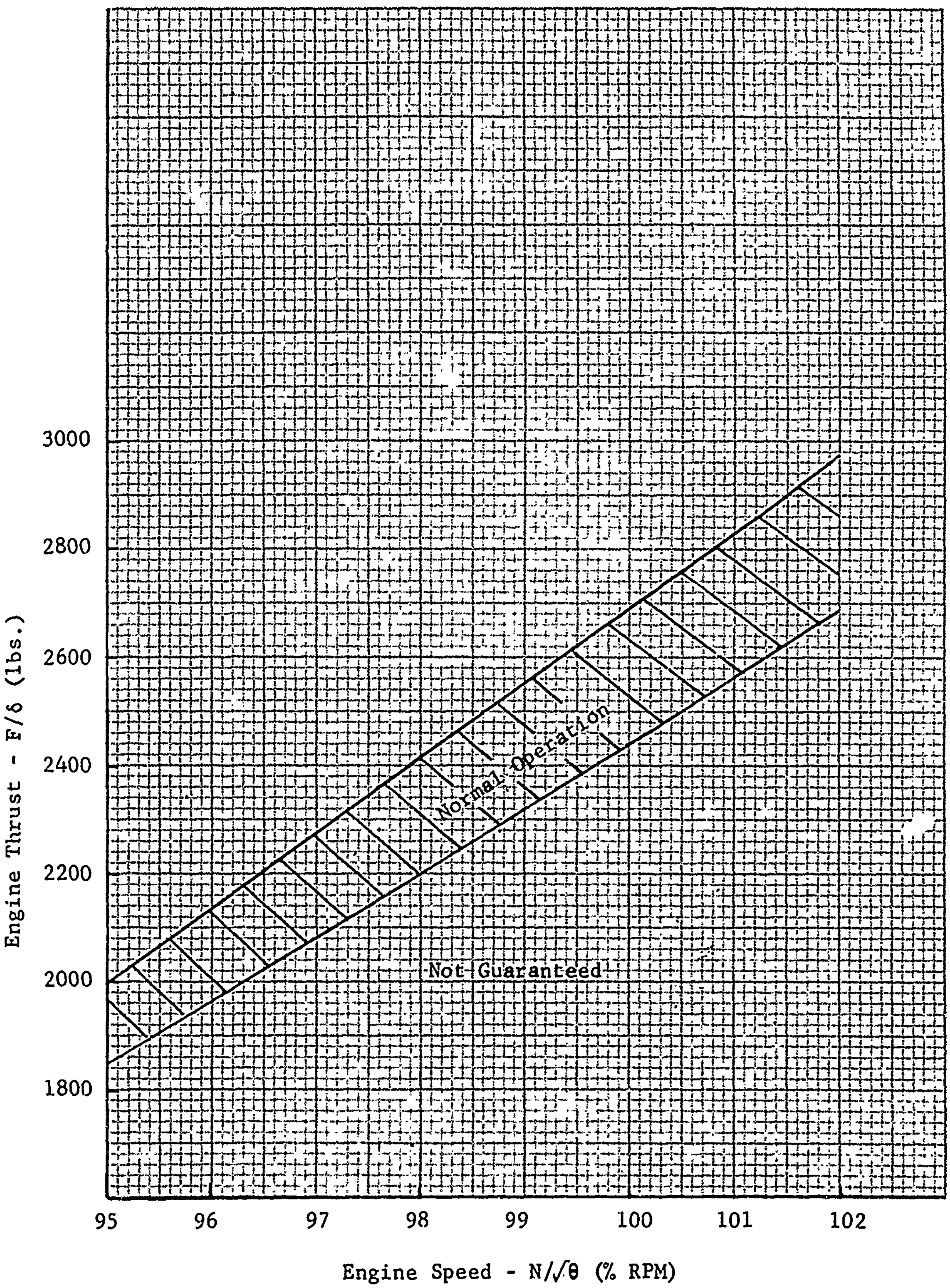


FIGURE 8.5 THRUST VERSUS ENGINE RPM

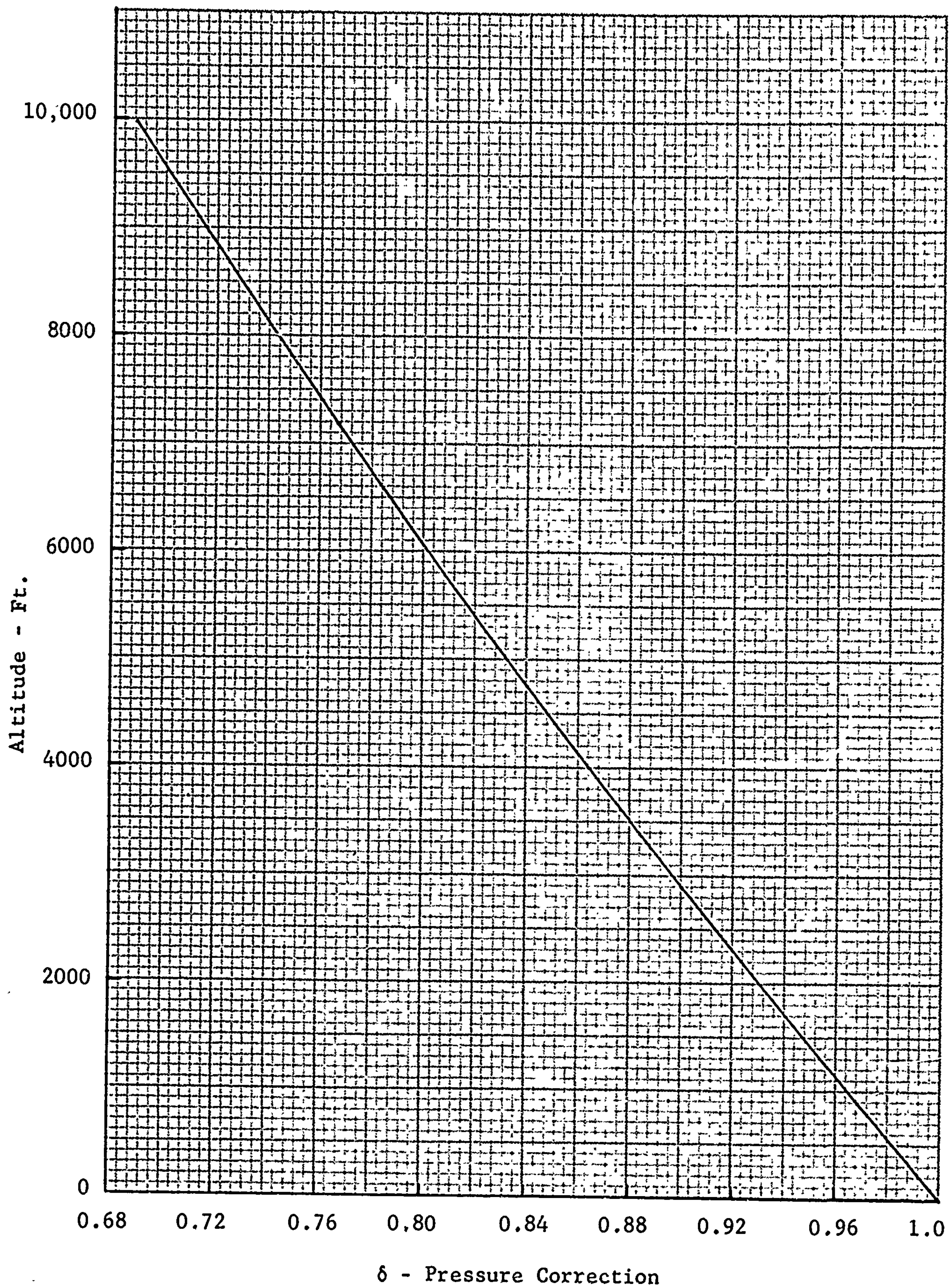


FIGURE 8.6 PRESSURE CORRECTION (δ) VERSUS ALTITUDE

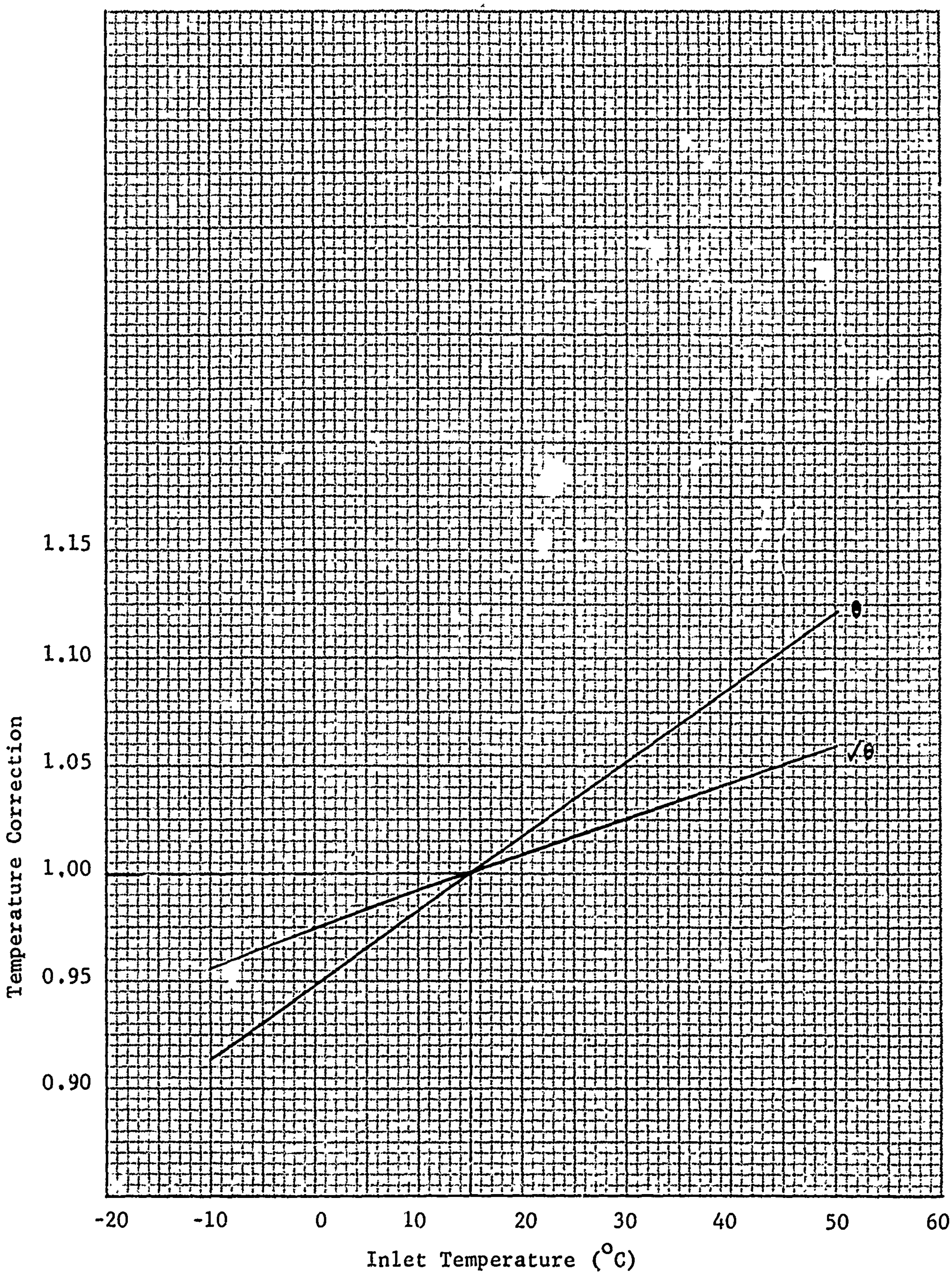


FIGURE 8.7A TEMPERATURE CORRECTION (θ) VERSUS INLET TEMPERATURE

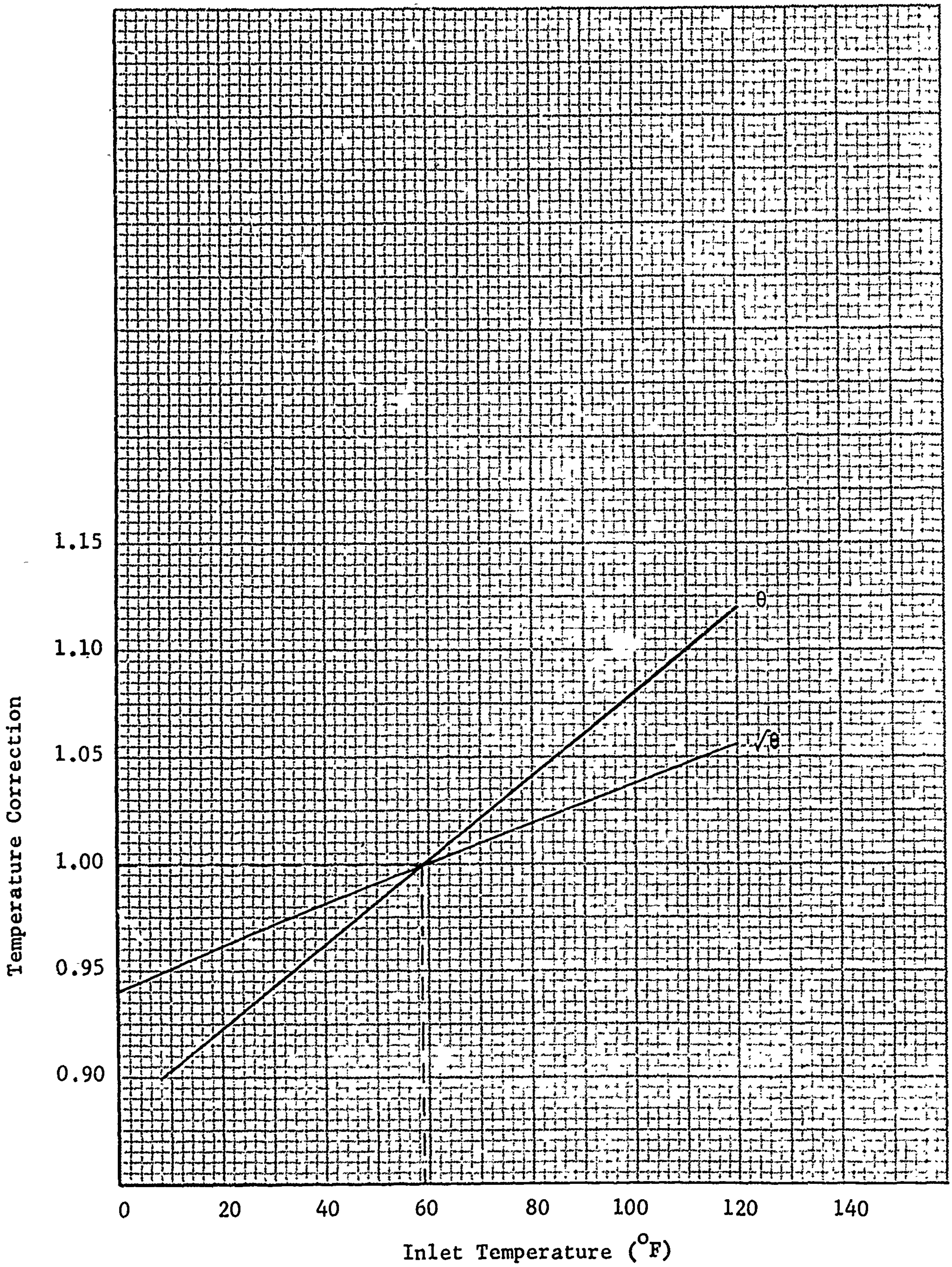


FIGURE 8.7B TEMPERATURE CORRECTION (θ) VERSUS INLET TEMPERATURE

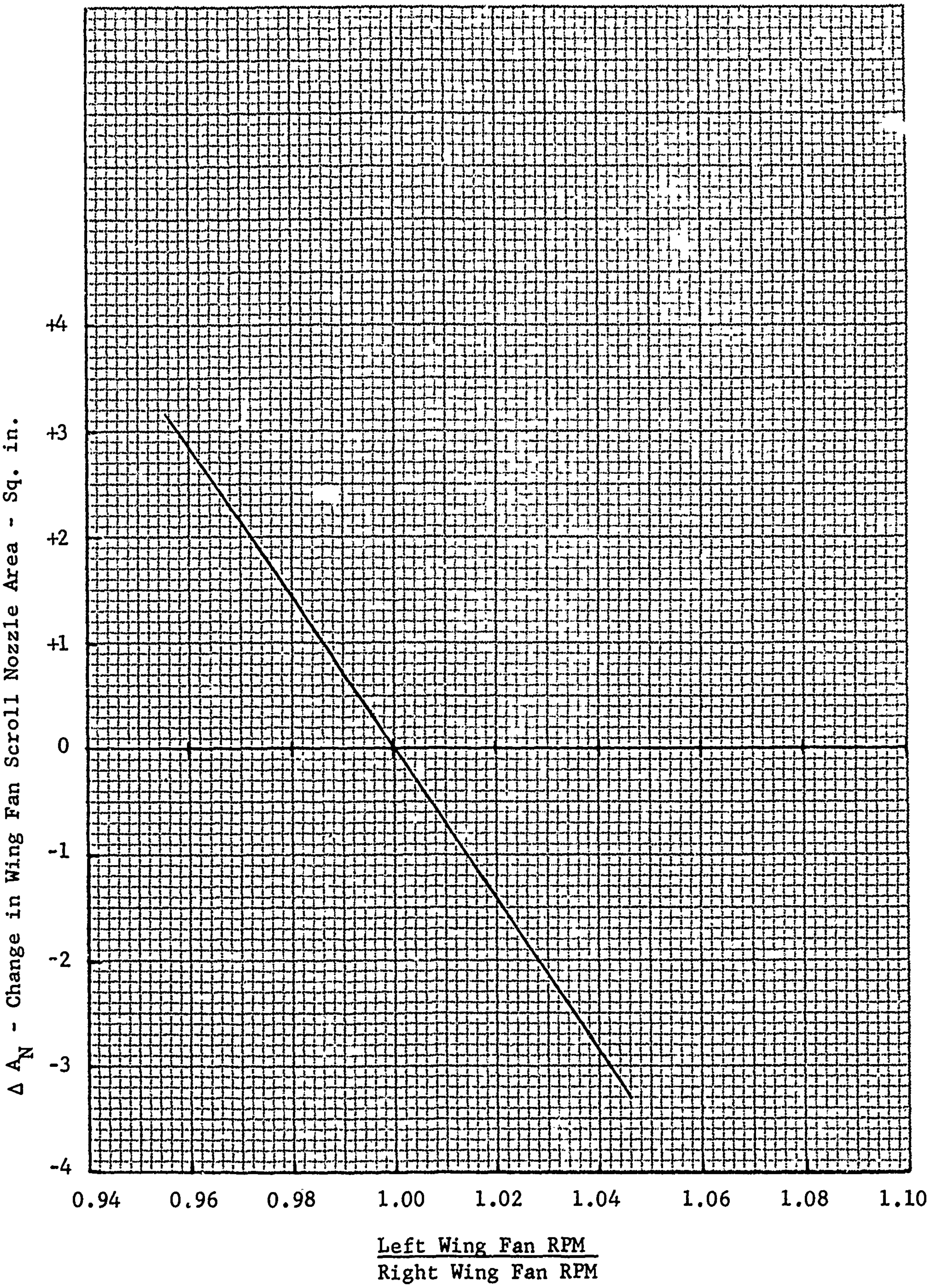
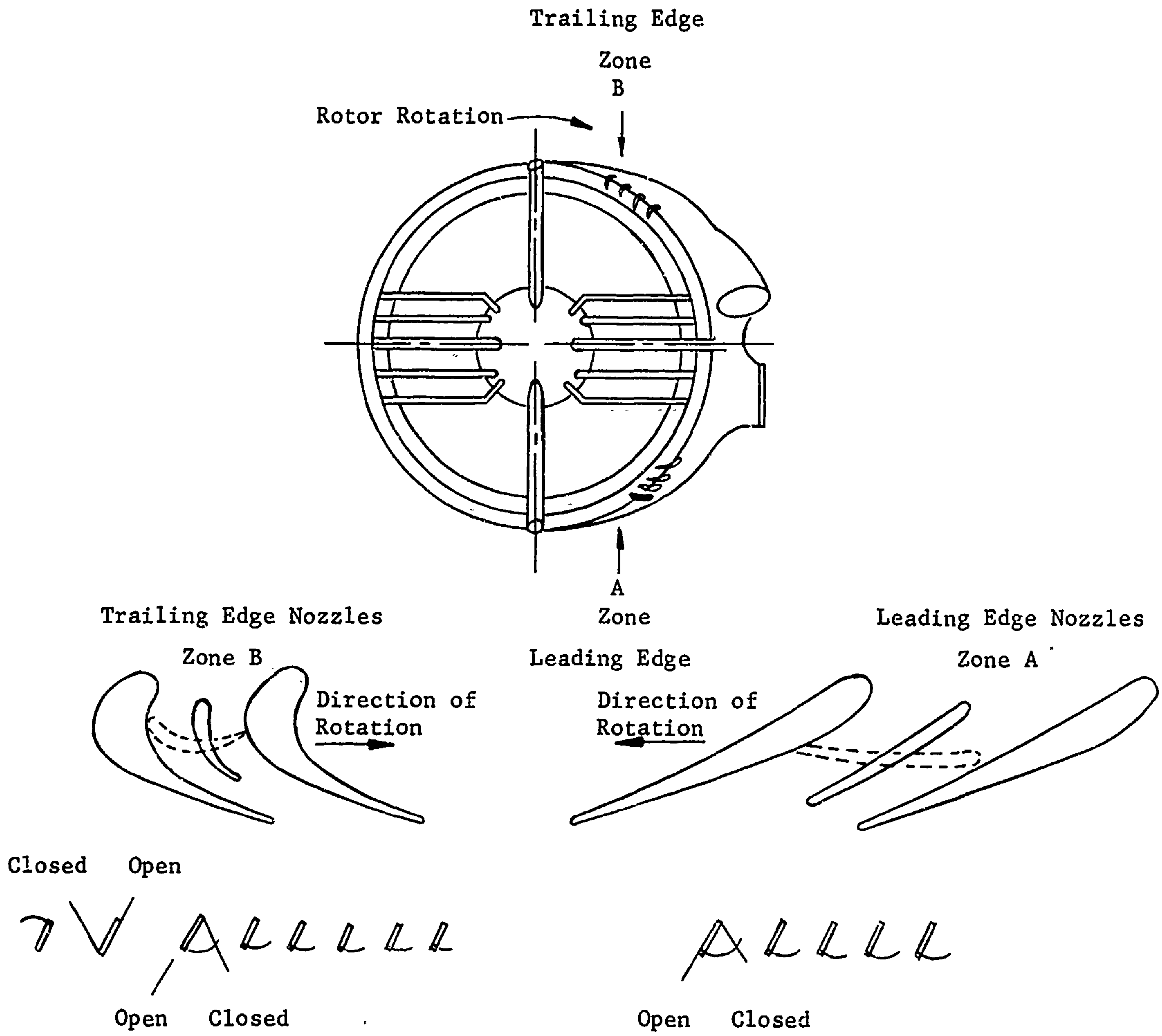
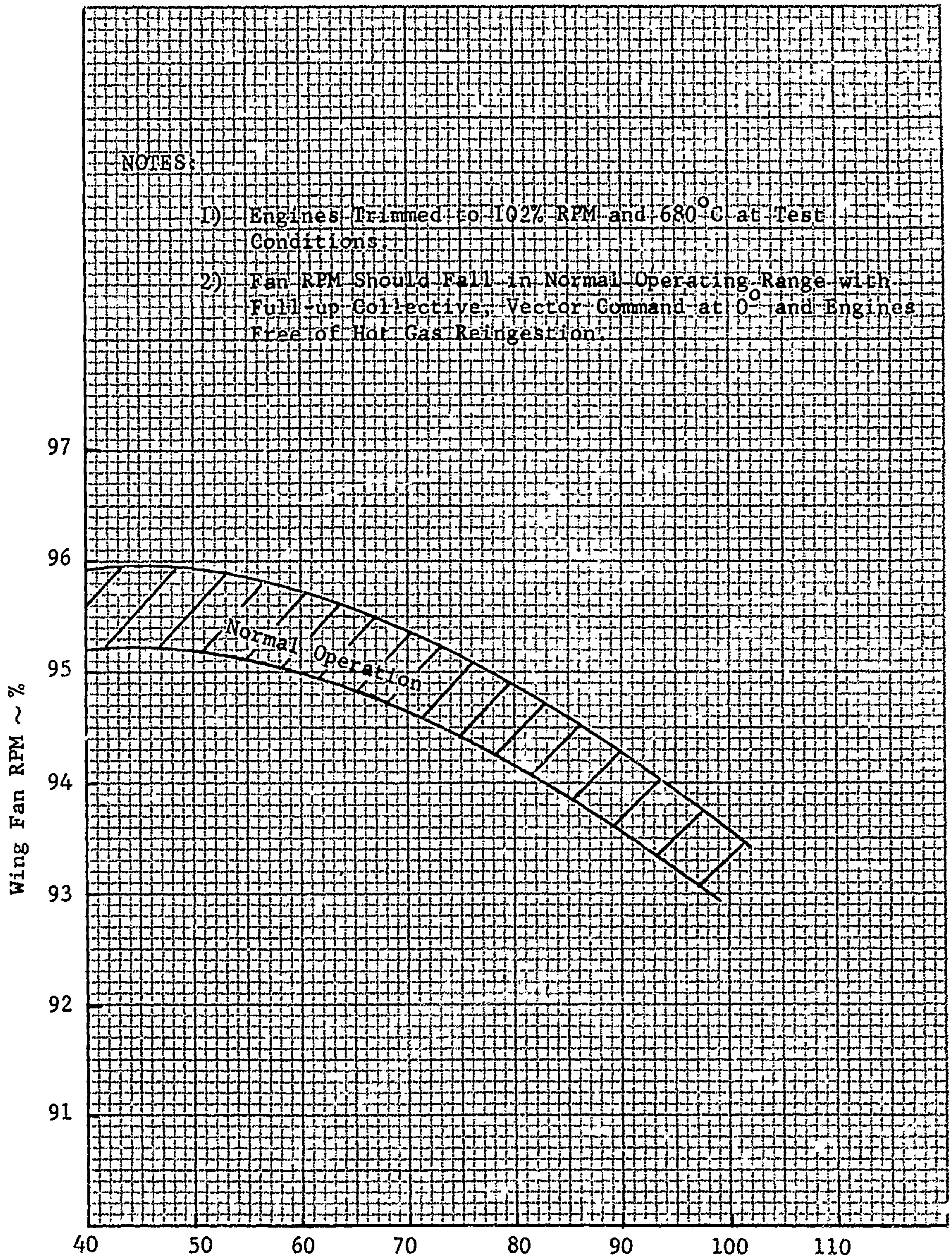


FIGURE 8.8 FAN SCROLL NOZZLE AREA CHANGES FOR BALANCING FAN RPM's



	Leading Edge Scroll Trim	Trailing Edge Scroll Trim
Maximum Area	58.27 sq. in.	58.27 sq. in.
Minimum Area	45.56 sq. in.	47.73 sq. in.
Number of Trim Vanes	5	8
Number of Vane Positions	4	4
Approximate Area Variation:		
Coarse (one vane open to closed)	2.54 sq. in.	1.32 sq. in.
Fine (per vane position)	0.85 sq. in.	0.44 sq. in.

FIGURE 8.9 SCROLL NOZZLE AREA TRIM (X353-5B)



Compressor Inlet Temperature ~ °F
(Ambient Temperature under Conditions of no Reingestion)

FIGURE 8.10A NORMAL WING FAN RPM CAPABILITY VERSUS AMBIENT TEMPERATURE FOR MAXIMUM GAS GENERATOR POWER

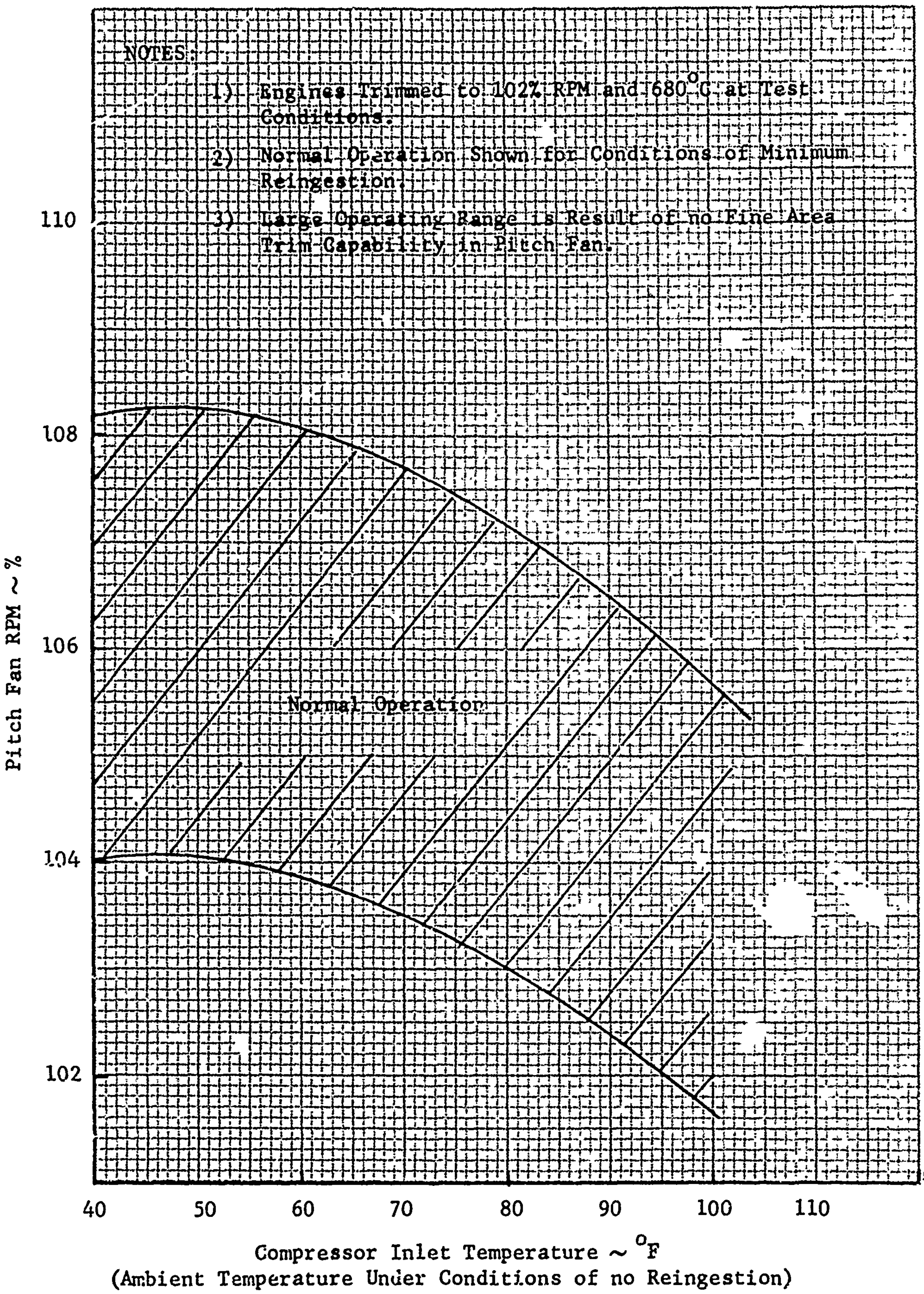


FIGURE 8.10B NORMAL PITCH FAN RPM CAPABILITY VERSUS AMBIENT TEMPERATURE FOR MAXIMUM GAS GENERATOR POWER

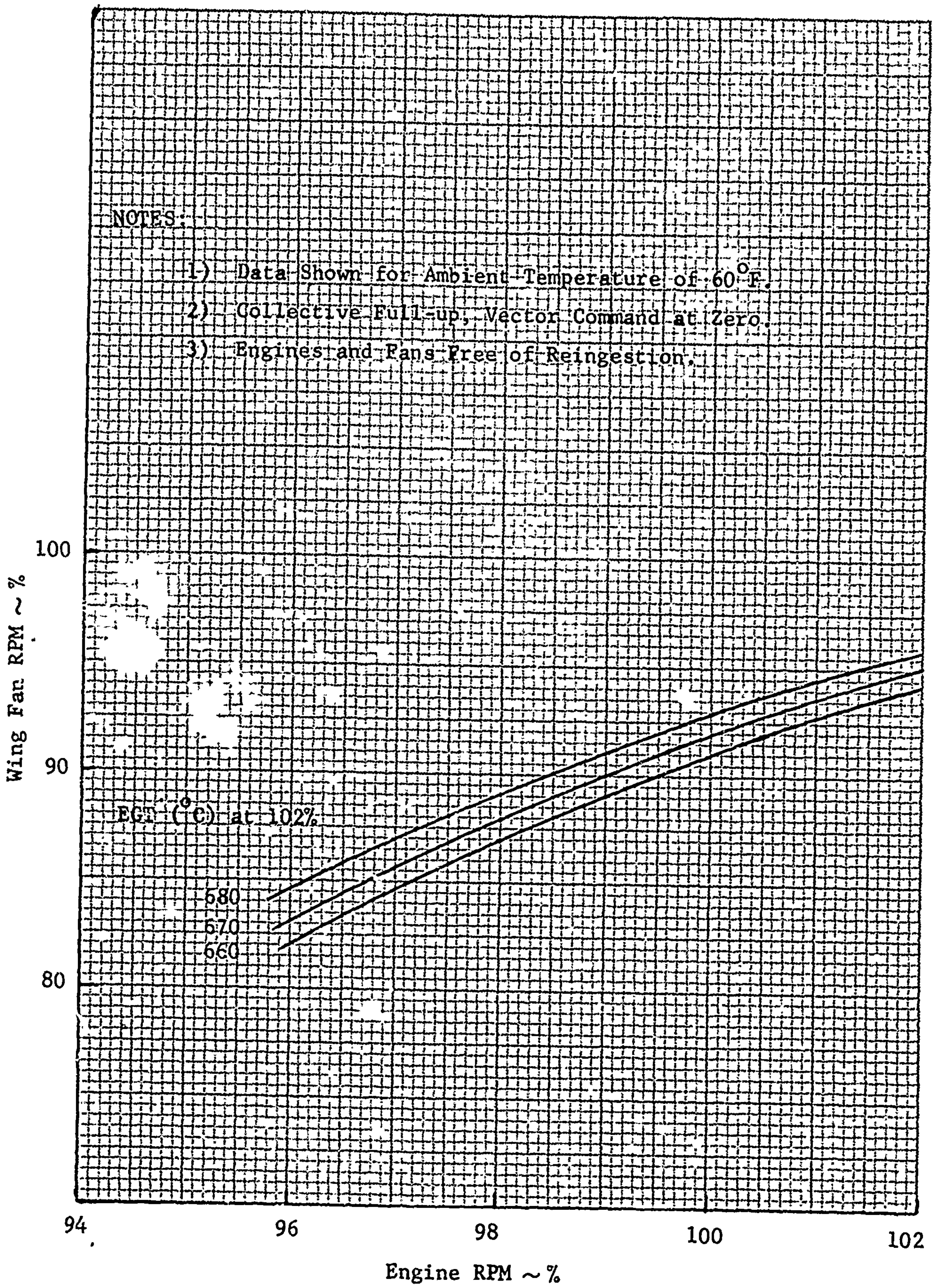


FIGURE 8.11 EFFECTS OF EGT AND ENGINE RPM ON FAN RPM

SECTION 9.

OPERATION OF X376 PITCH TRIM CONTROL FAN

9.1 GENERAL

a. Operating limits of the X376 pitch trim control fan are included in Section VIII of this manual for reference. Detailed operating limits including flight envelopes, flight starting, jet wake diagrams, and system requirements are included in the following publications:

1. J85-GE-5 Model Specification
2. X376 Pitch Trim Control Fan Specification No. 113

b. Ground procedures are provided in both the J85-GE-5 Overhaul and Maintenance Manuals and Section VIII of this manual. In-flight procedures for the J85-GE-5 turbojet engine should be obtained directly from:

The General Electric Company
Small Aircraft Engine Department
Turbotown, Massachusetts

c. For information on all other procedures related to hover or transition flight, such as control malfunction, etc., refer to the XV-5A Aircraft Operating Instructions.