



**Detroit Diesel Allison** Division of General Motors Corporation

P. O. Box 894 ■ Indianapolis, Indiana 46206

7 August 1979

SUBJECT: Transmittal of First Edition, Eleventh Revision, dated 7 August 1979 to the 250-B17 Operation and Maintenance Manual, Publ 11W2

TO: All Holders of Subject Manual

1. Collating Instructions

- a. Remove the yellow pages of temporary revision 3-1. Also, remove all superseded pages from the manual and insert the revised pages in their respective places.
- b. Use the 7 August 1979 List of Pages to ensure that your manual is complete.

2. Revision Content

- a. Compressor front bearing and oil seal replacement procedures have been revised. Procedures cover engine installed in aircraft or engine removed from aircraft.
- b. The thermocouple inspection has been changed.
- c. The start-derichment adjustment procedure has been expanded. A start/acceleration adjustment procedure has been added.
- d. Recently released tools required for engine maintenance have been included.
- e. A requirement for lightning strike inspection has been added.
- f. The beta control lever rigging procedures have been clarified. Procedures cover rigging with the propeller installed or with the propeller removed.
- g. The compressor case replacement procedure has been revised to give a bolt tightening sequence.

R. L. Cassman  
General Supervisor  
Publications

# Operation and Maintenance Manual

## Allison Gas Turbines

### **TURBOPROP MODELS 250-B17, B17B, B17C**

This manual is not complete for the 250-B17C engine without the appropriate supplement.

1 SEPTEMBER 1971  
REV. 7 AUGUST 1979

*Federal Aviation Administration Approved*



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Indianapolis, Indiana 46206

NOTICE—This data is furnished with the understanding that it will be used for operational, service and maintenance purposes only, and not to manufacture or procure the manufacture of the part shown and/or described.

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A

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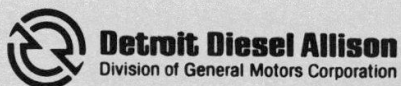
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## 250-B17 Operation and Maintenance

### COMMERCIAL SERVICE INFORMATION

Commercial service information incorporated in whole, in part, or by reference in this operation and maintenance manual includes:

<u>Commercial Service Letters</u>	<u>Date Incorporated</u>
250-B17 TP CSL-1009	3-15-77
250-B17 TP CSL-1012	10-25-74
250-B17 TP CSL-1017	6-16-75
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250 - B17 Operation and Maintenance

## INTRODUCTION

This publication provides descriptive information, operating instructions and maintenance information for the Detroit Diesel Allison Division Model 250-B17 and Model 250-B17B turbo-prop engines.

The engines consists of a multistage axial-centrifugal-flow compressor, a single combustion chamber, a two-stage gas producer turbine, and a two-stage power turbine which supplies output power of the engine through the power and accessories gearbox and propeller reduction gearbox. The engines also have a mechanical coordinator for use with a beta control valve to give the engine reverse thrust capability.

The procedures and limits in this manual constitute the manufacturer's official recommendations for engine operation. All information has been correlated with our Service and Engineering Groups for technical accuracy.

Every task outlined in the Operation and Maintenance Manual has been successfully accomplished by organizations and individuals at the field maintenance level.

It is not expected that every organization or individual will possess the required special tooling, training, or experience to perform all tasks outlined. However, any task outlined

herein may be performed if in the opinion of the organization or individual, the following conditions are met.

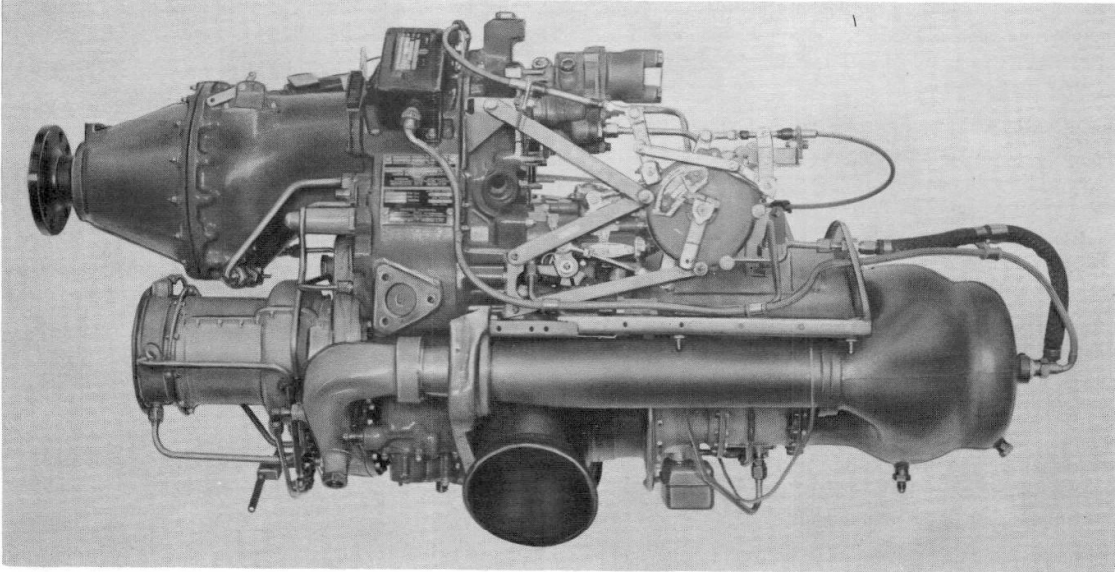
- a. Requisite knowledge of the of the task either through:
  - (1) Formal instruction in a DDA or distributor training facility.
  - (2) "On-the-job" instruction by a DDA or distributor representative.
  - (3) Experience in performing the task.
- b. Suitable work environment to prevent contamination or damage to engine parts or modules.
- c. Suitable tools and fixtures as outlined in the Operation and Maintenance Manual.
- d. Reasonable and prudent maintenance practices are utilized.
- e. Requirements of the applicable regulatory authority regarding maintenance procedures are met.

Maintenance organizations and individuals are encouraged to contact DDA through its world wide distributor network for information and guidance on any of the tasks outlined herein.



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273475M

Engine Left Side View



## SECTION I DESCRIPTION

### 1-1. GENERAL.

1-2. Engine description includes a discussion of each major component and each major system of the engine.

1-2A. Numerical values in this manual are given in terms standard to existing practices in the United States. English-to-metric conversion tables have been included in Appendix A of this manual to assist the reader in converting handbook values to equivalent SI metric units (International System of Units).

### 1-3. COMPONENTS.

1-4. The major engine components are a compressor, combustion section, turbine, power and accessories gearbox and a propeller reduction gearbox. (See frontispiece.)

### 1-5. COMPRESSOR.

1-6. The compressor assembly consists of a compressor front support, case assembly, rotor wheels with blades, centrifugal impeller, front diffuser assembly, rear diffuser assembly, diffuser vane assembly, and diffuser scroll. Air enters the engine through the compressor inlet and is compressed by six axial compressor stages and one centrifugal stage. The compressed air is discharged through the scroll type diffuser into two external ducts which convey the air to the combustion section. (See figure 1-1.)

### 1-7. COMBUSTION SECTION.

1-8. The combustion section consists of the outer combustion case and the combustion liner. A spark igniter and a fuel nozzle are mounted in the aft end of the outer combustion case. Air enters the single combustion liner at the aft end through holes in the liner dome and skin. The air is mixed with fuel sprayed from

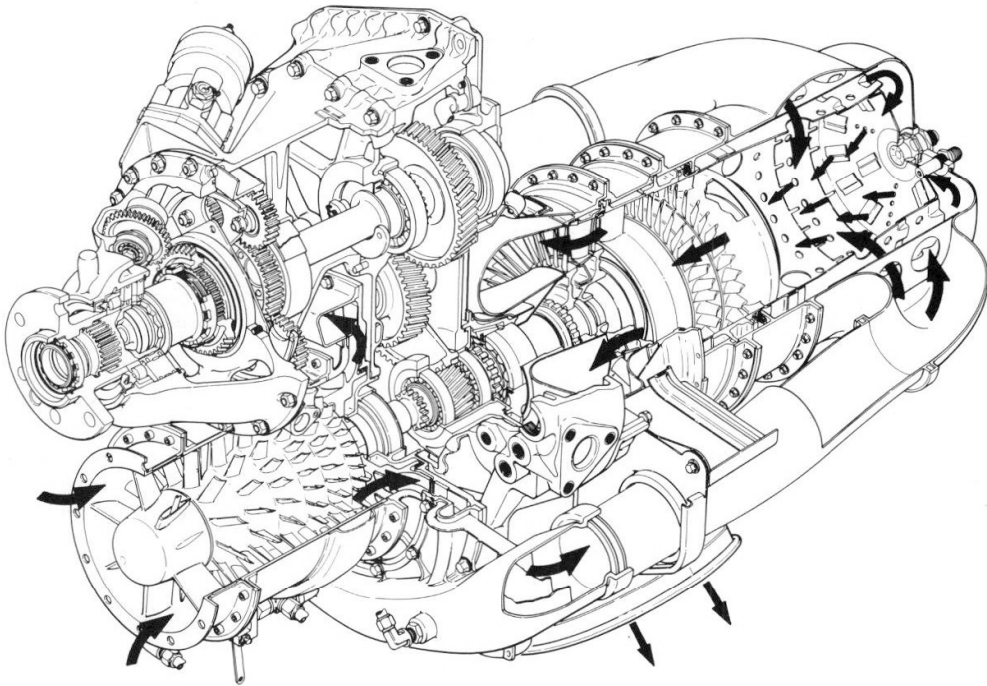
the fuel nozzle and combustion takes place. Combustion gasses move forward out of the combustion liner to the first-stage gas producer turbine nozzle.

### 1-9. TURBINE.

1-10. The turbine consists of a gas producer turbine support, a power turbine support, a turbine and exhaust collector support, a gas producer turbine rotor and a power turbine rotor. The turbine is mounted between the combustion section and the power and accessories gearbox. The two-stage gas producer turbine drives the compressor and accessories gear train. The two-stage power turbine furnishes the output power of the engine. The expanded gas discharges in a downward direction through the twin ducts of the turbine and exhaust collector support.

### 1-11. POWER AND ACCESSORIES GEARBOX.

1-12. The main power and accessories drive gear trains are enclosed in a single gear case. The gear case serves as the structural support of the engine. All engine components including the engine mounted accessories are attached to the case. A two-stage helical and spur gear set is used to reduce rotational speed from 33,290 rpm at the power turbine to 6016 rpm at the power takeoff drive splines. The forward spline drives a direct-mounted propeller reduction gearbox. Accessories driven by the power turbine gear train are the power turbine tachometer-generator and the propeller overspeed (backup) governor. The gas producer gear train drives the compressor, fuel pump, gas producer tachometer-generator, and gas producer fuel control. The starter-generator drive and a spare drive are in this gear train.



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Figure 1-1. Engine Air Flow

**1-13. PROPELLER REDUCTION GEARBOX.**

1-14. The propeller reduction gearbox mounts on the forward side of the power and accessories gearbox and is driven by the forward power takeoff drive spline. It incorporates a planetary gear set which provides a speed reduction from 6016 to 2030 rpm. A bevel gear mounted on the propeller shaft serves as a drive for the reduction gear mounted propeller-power turbine governor assembly.

**1-15. SYSTEMS.**

- 1-16. The major systems of the engine are as follows:
- a. Power Control
  - b. Lubrication
  - c. Electrical
  - d. Anti-icing
  - e. Compressor Bleed Air

**1-17. POWER CONTROL SYSTEM.**

1-18. The power control system includes both fuel and propeller control functions. The hardware making up the fuel control function includes: a gas producer fuel control, a combination propeller-power turbine governor assembly, a propeller overspeed governor, a coordinator, a fuel pump and filter assembly and a fuel nozzle. (See figure 1-2.)

1-19. The propeller control function uses the propeller governor of the propeller-power turbine governor assembly, the propeller overspeed (backup) governor, and a non engine furnished beta control valve. A mechanical coordinator assembly links power control system accessories levers to cockpit controls.

**1-20. Gas Producer Fuel Control.** The gas producer fuel control responds to input from compressor discharge pressure ( $P_c$ ), gas producer turbine speed ( $N_1$ ), and power lever (throttle) angle.

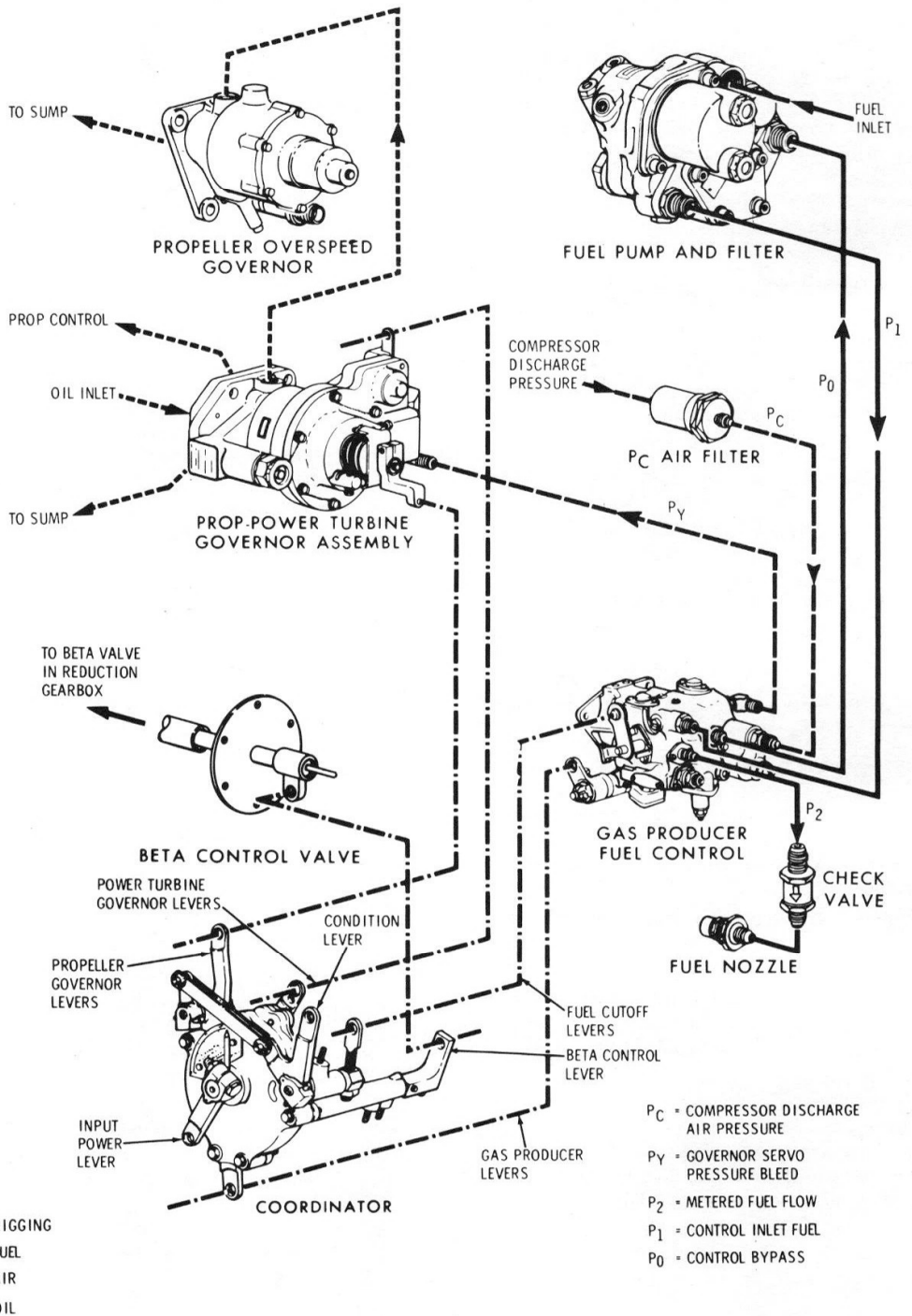


Figure 1-2. Power Control System



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1-21. The gas producer fuel control has a bypass valve, metering valve, acceleration bellows, governor bellows, manually operated cutoff valve, maximum pressure relief valve, a torque tube seal and lever assembly, and a start derichment valve. (See figure 1-3.) Fuel enters the control from the engine fuel pump and filter assembly and is conveyed to the metering valve. The bypass valve maintains a constant pressure differential across the metering valve and bypasses excess fuel back to the fuel pump and filter assembly through an external line connecting the pump bypass inlet to the bypass outlet port of the gas producer fuel control.

1-22. The metering valve is operated by lever action through movement of the governor and acceleration bellows. Metering valve area is a function of valve travel. Before light-off and acceleration the metering valve is established at a predetermined open position by the acceleration bellows (aneroid) under influence of ambient pressure ( $P_c$  at zero compressor rpm).

1-23. During light-off and acceleration to a set  $P_c$ , the start derichment valve is open allowing  $P_y$  pressure to vent to atmosphere. Venting  $P_y$  allows the governor bellows to move the metering valve against the min flow stop. At min flow the metering valve provides the required lean fuel schedule after light-off. As compressor rpm increases the derichment valve is closed by  $P_c$  acting on the derichment bellows. When the derichment valve is closed, control of the metering valve is returned to the normal operating schedule. The derichment schedule can be varied by a manual adjustment on the fuel control.

1-24. During acceleration the  $P_x$  and  $P_y$  pressures are equal to the modified compressor discharge pressure ( $P_c$ ) up to the point where the speed enrichment orifice is opened by flyweight action. Opening the speed enrichment orifice bleeds  $P_x$  pressure while  $P_y$  remains at a value equal to  $P_c$ . Under the influence of the  $P_y$  minus  $P_x$  pressure drop across the governor bellows, the metering valve moves toward the max flow stop where it provides increased fuel flow.

1-25. Gas producer speed is controlled by the gas producer fuel control governor. A set of flyweights operate the governor lever which controls governor bellows ( $P_y$ ) bleed at the governing orifice. Flyweight operation of the governor lever is opposed by a variable spring load. The spring force is established by the gas producer fuel control lever acting on a spring scheduling cam. Opening the governing orifice bleeds  $P_y$  pressure and allows  $P_x$  pressure to control the governor bellows. The  $P_x$  influence on the bellows moves the metering valve toward min flow and at a position where metered flow is at steady state requirements.

### 1-26. Propeller-Power Turbine Governor Assembly.

The power turbine governor and the propeller speed governor are integrated into a single component which provides power turbine speed governing-limiting and propeller speed control. The direct coupling between the power turbine and the propeller permits the propeller governor to take over the power turbine speed governing function. During forward thrust operation the power turbine governor serves only as engine  $N_2$  overspeed protection.

1-27. The propeller governor matches load torque to engine torque by varying the pitch of the propeller.

1-28. During "on speed" conditions the propeller operating servo oil supply and drain ports in the governor are closed; this maintains a constant engine speed and propeller blade pitch.

1-29. At underspeed conditions the flyweight counteracting spring force lowers the pilot valve plunger to open the ports in the governor which supply servo oil to the propeller operating piston. Increased oil pressure at the piston decreases propeller blade pitch; this reduces load torque and increases engine speed. When engine speed increases to the set point, the flyweight action and counteracting spring force reach a balance which maintains the pilot valve plunger at the "on speed" position.

1-30. At overspeed conditions the flyweight action overcomes the counteracting spring force to raise the pilot valve plunger. The plunger moves to the position which opens the governor ports that allow servo oil to drain from the propeller operating piston. Reduced servo pressure allows the propeller counterweights to increase blade pitch. Increased pitch increases load and decreases engine speed. When engine speed decreases to the set point, the flyweight action and counteracting spring force reach a balance which maintains the pilot valve plunger at the "on speed" position.

1-31. Propeller feathering is accomplished when the propeller governor lever (via the condition lever) is moved to the minimum setting. At the minimum setting the lever raises the pilot valve plunger to the position which opens the ports that allow servo oil to drain from the propeller operating piston. Oil is forced from the propeller servo by a feathering spring in the propeller hub. The absence of servo pressure allows the propeller counterweights to increase blade pitch to the feather position.

1-32. At reverse thrust and forward thrust operation through taxi, propeller blade angle is established directly by the power lever through the beta valve.

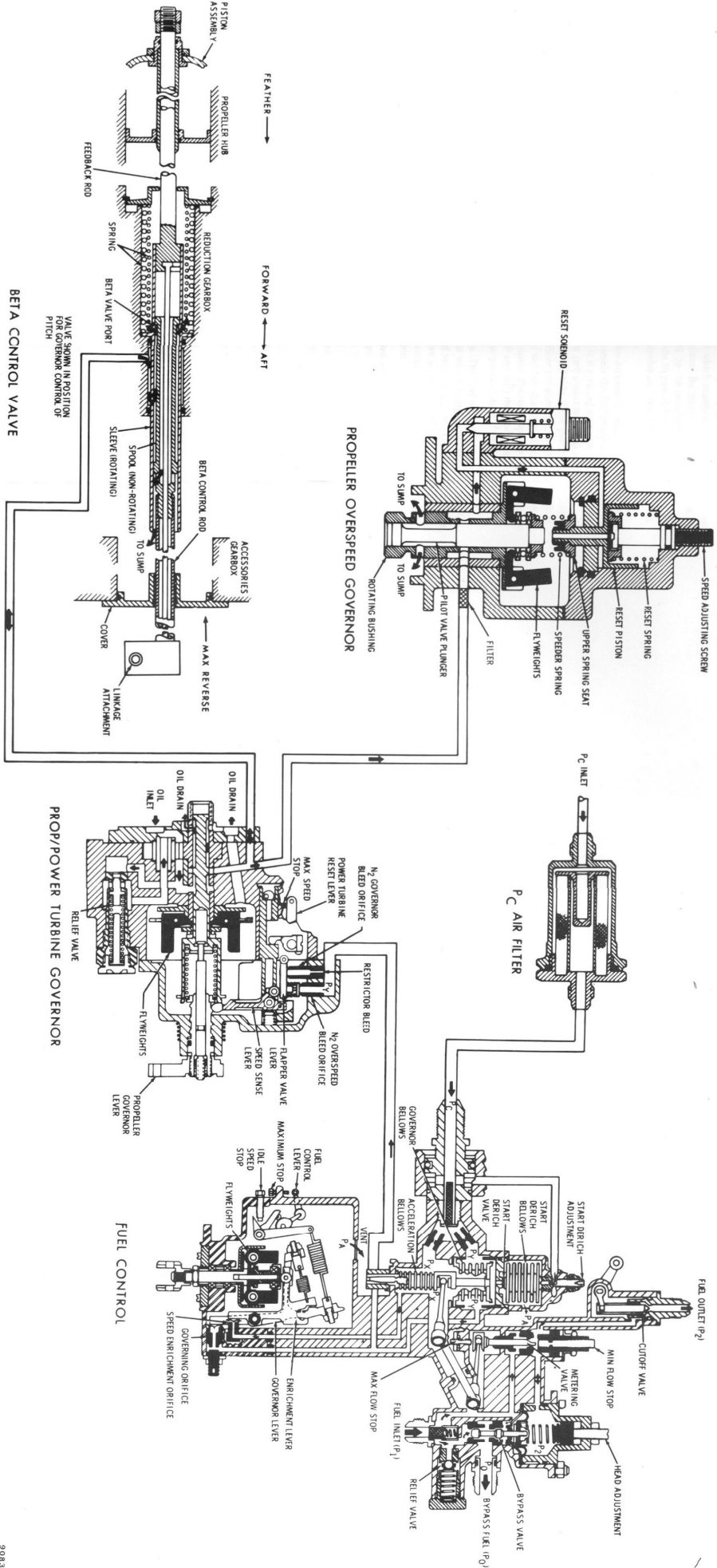


Figure 1-3. Fuel Control and Propeller Governing Systems Schematic



1-33. The power turbine governor section of the propeller-power turbine governor assembly serves as overspeed and loss of load protection for the engine. The governor provides a means of bleeding  $P_Y$  pressure from the gas producer fuel control acceleration bellows.

1-34. The power turbine governor uses the same flyweight system that is used by the propeller governor. Shaft movement resulting from flyweight counteracting spring force (underspeed) lowers the speed sense lever. The speed sense lever acts upon the flapper valve lever to keep the orifices closed. As long as the orifices remain closed the power turbine governor has no controlling influence on engine operation.

1-35. Shaft movement resulting from flyweight action which overcomes the counteracting spring force (overspeed) raises the speed sense lever. The speed sense lever acts upon the flapper valve lever to move it off the overspeed bleed orifice when the set speed is exceeded. Opening the overspeed bleed orifice bleeds  $P_Y$  pressure from the fuel control. Bleeding  $P_Y$  pressure allows the fuel control metering valve to move toward min flow to a position where  $N_2$  speed decreases to the set speed and metered fuel flow is at steady state requirements.

1-36. Normally the overspeed bleed orifice is set to open at approximately 6% above the propeller governor speed setting when the power turbine reset lever (via power lever) is at the max stop position. With the reset lever at the minimum position the orifice will open at approximately 6% below propeller governor speed setting.

1-37. During a severe  $N_2$  overspeed (such as occurs during a loss of load), the flapper valve lever continues to move until the overspeed bleed trip orifice opens. This allows  $P_Y$  pressure to dump, causing the fuel control metering valve to move to the min flow position.

1-38. The overspeed trip bleed orifice is set to open at approximately 14% above the propeller governor speed setting when the power turbine reset lever is at the maximum stop position. With the reset lever at the minimum position the orifice will open approximately 2% above the propeller governor speed setting.

**1-39. Fuel Pump and Filter Assembly.** (See figures 1-4 and 1-4A.) The fuel pump and filter assembly incorporates a single gear-type pumping element, a low pressure barrier filter, a filter bypass valve, and a bypass pressure regulating valve. Fuel enters the engine fuel system at the inlet port of the pump and passes through the low pressure filter before entering the gear element. The filter bypass valve allows fuel to bypass the filter element if it becomes clogged.

1-40. The bypass return flow from the fuel control is passed back to the inlet of the gear element through a pressure regulating valve which maintains the bypass flow pressure above inlet pressure. By means of passages leading to auxiliary filling ports on the periphery of the gear element, a portion of the bypass flow is used to fill the gear teeth when vapor-liquid conditions exist at the inlet to the gear element.

1-41. The 5 micron nominal/15 micron absolute replaceable filter is located inside the fuel pump assembly upstream of the gear element. It is retained by a cast cover attached to the pump housing by two socket head cap screws. The cover is located on the aft side of the pump. To minimize fuel spillage during filter replacement, fuel may be drained through the lower of the two drain ports located on the aft face of the filter cover. Pressure taps are provided before and after (labeled BF and AF) the filter element to permit measurement of filter pressure drop if desired.

**1-42. Fuel Nozzle.** The fuel nozzle is a single-entry, dual-orifice type unit which contains an integral valve for dividing primary and secondary flow. This same valve acts as a fuel shutoff valve when the fuel manifold pressure falls below a predetermined pressure, thus keeping fuel out of the combustion chamber at shutdown.

**1-43. Propeller Overspeed Governor.** The propeller overspeed governor provides propeller overspeed protection which backs up the protection afforded by the power turbine governor. (See figure 1-2.) The overspeed governor is connected to the propeller operating hydraulic circuit between the propeller governor and the propeller operating piston.

1-44. Flyweights in the governor are driven at  $N_2$  speed. When the overspeed set limit is exceeded, the flyweights overcome the counteracting spring to raise the pilot valve plunger to a position where the valve is open and propeller operating oil is dumped into the gearbox sump. Reduction of oil pressure at the propeller operating piston allows the propeller counterbalance weights to move the propeller blade to an increased pitch position where load torque is increased and engine speed is decreased.

1-45. The propeller overspeed governor is equipped with a solenoid that is used by the aircraft pilot to check operation of the propeller overspeed protection system without exceeding the operating limits of the engine. Energizing the solenoid routes propeller operating oil pressure to the governor cover where it opposes the flyweight counteracting spring force. Lessening the spring force allows the flyweights to move the pilot valve plunger at a lower  $N_2$  speed. When the plunger moves



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to the position where the valve is open, propeller operating oil is dumped into the gearbox sump and the propeller moves toward the feather position. De-energizing the solenoid removes the propeller operating oil opposing the flyweight counteracting spring. This allows the

spring to return the pilot valve plunger to the closed position and returns governor operation to the established set point. Operation of the governor may be checked at any engine speed above approximately 80%.

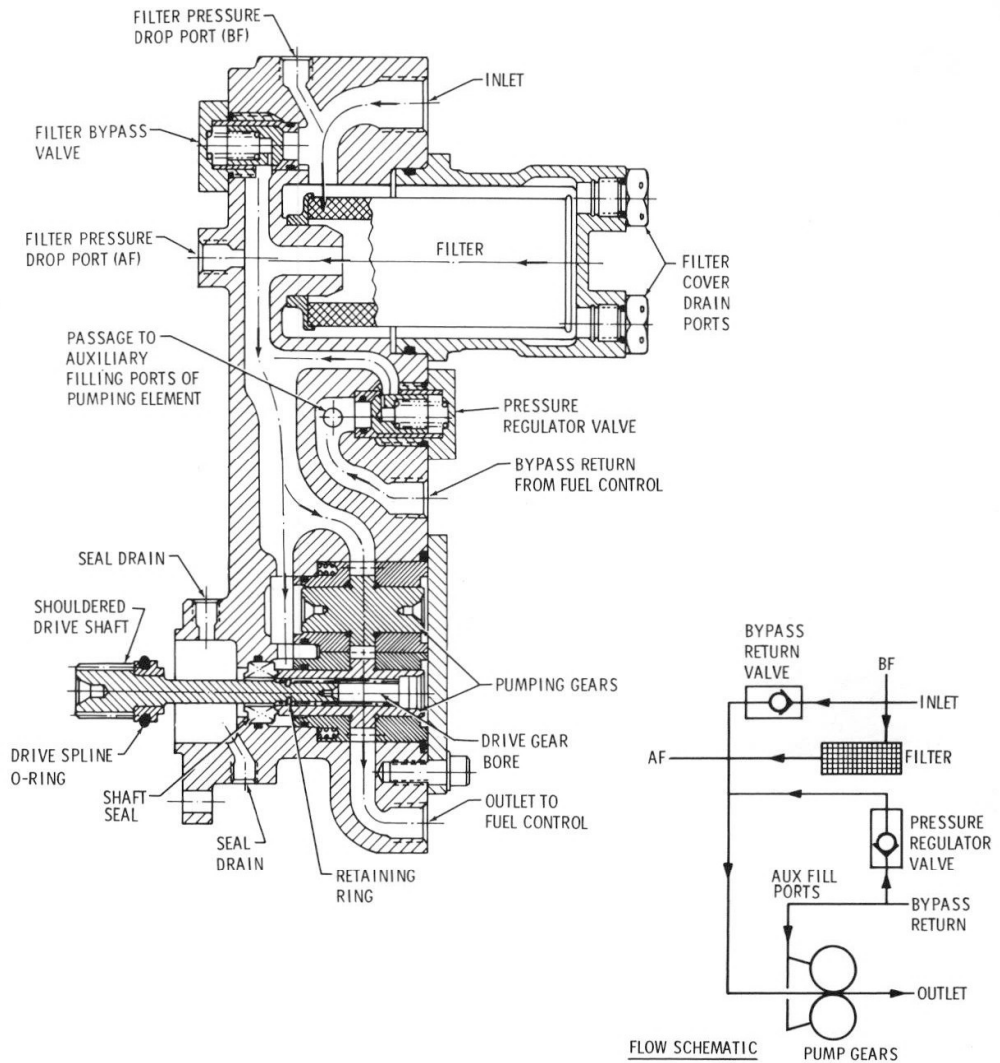


Figure 1-4. Fuel Pump Assembly (Sundstrand)

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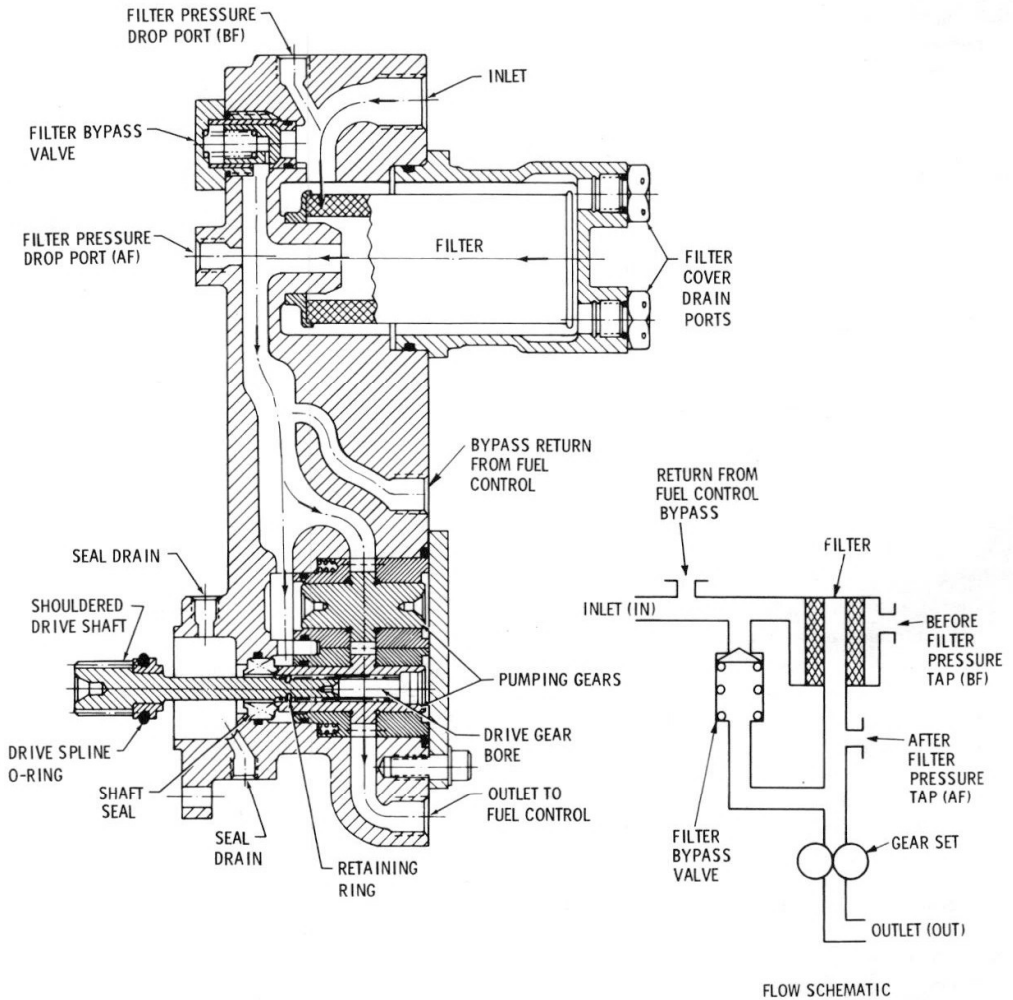


Figure 1-4A. Single Element Fuel Pump Assembly (TRW)

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### 1-46. Beta Control Valve.

1-47. The beta valve incorporates a non-rotating spool valve located inside a rotating valve sleeve. The rotating sleeve is mechanically connected to a piston in the propeller hub and follows axial movement of the piston. A beta control rod connected to the spool valve serves to position the spool valve axially in relation to power lever position.

1-48. The beta valve acts as a hydraulic low pitch stop for the propeller. Servo pressure oil from the propeller-power turbine governor is routed through the valve sleeve to move the piston forward and drive the propeller blades toward a lower pitch. As the piston moves forward, the valve sleeve is also moved forward. Forward movement will continue until the beta valve port is closed by the spool valve. When the beta valve port is closed, oil flow to the piston is cut off to prevent further decrease in blade pitch.

1-49. To select reverse pitch, the spool valve is moved forward by power lever movement. Movement of the spool valve uncovers the beta valve port. Servo pressure oil is routed to the piston causing the piston to move forward to drive the blades to a reverse pitch position. Piston forward movement also moves the valve sleeve forward until the beta valve port is again covered by the spool valve land, at which time the pitch is fixed at the desired angle.

1-50. When the power lever is moved out of reverse or toward takeoff, the spool valve is repositioned rearward. Rearward movement of the spool valve uncovers the beta valve port. This allows oil to vent from the piston cavity through the beta valve port to the gearbox sump through a drain passage inside the spool valve. Reduction of oil pressure on the piston allows spring force to move the piston and valve sleeve rearward. As the piston moves rearward, blade angle increases. Piston and sleeve rearward movement continues until the beta valve port is again covered by the spool valve land at which time pitch is controlled at the proper angle to maintain a constant speed.

1-51. **Coordinator.** The coordinator assembly is mechanically operated. The function of the coordinator is to provide automatic sequencing of the multiple power plant controls in response to input from the pilot operated power (throttle) and condition levers.

a. **Input Power Lever.** The coordinator input power lever allows thrust modulation from Takeoff to Maxi-

imum Reverse. Total angular travel is 95 degrees. Specific positions on the lever are: Max Power (95°), Flight Idle (40°), Ground Idle and Start (30°), and Max Reverse (0°). Refer to figure 4-57 for power lever control schedule.

b. **Condition Lever.** The coordinator condition lever allows engine starting and shutdown, propeller feathering and fuel shutoff, and the capability to vary the propeller governor setting between 80 and 100% of propeller speed. Total angular travel is 40 degrees. Specific positions of the lever are: 100% Propeller Speed (40°), Minimum Propeller Speed Setting (18°), and Fuel Shutoff and Propeller Feathering (0°). Refer to figure 1-5 for condition lever control schedule.

### 1-52. LUBRICATION SYSTEM. (See figure 1-6.)

1-53. The lubrication system is a dry sump type with an external reservoir and heat exchanger. A gear type pressure and scavenge pump assembly is mounted within the power and accessories gearbox. (See figure 1-7.) The oil filter, filter bypass valve, and pressure regulating valve are in a unit which is located in the lower left hand side of the power and accessories gearbox housing and are accessible from the bottom of the engine. A check valve is located between the housing and the filter unit. Indicating-type magnetic plugs are installed in the power and accessories gearbox at the bottom and at the engine oil outlet connection. The system has a third magnetic drain plug in the bottom of the propeller reduction gearbox. All engine oil system lines and connections are internal with the exception of pressure and scavenge lines to the compressor front support, the gas producer turbine support, the power turbine support, and the propeller reduction gearbox. There is also an external oil line between the propeller-power turbine governor assembly and the propeller overspeed (backup) governor.

### 1-54. IGNITION SYSTEM. (See figure 1-8.)

1-55. The engine ignition system consists of a low tension capacitor discharge ignition exciter, a spark igniter lead, and a shunted surface gap spark igniter. The system derives its input power from a 14 to 29 volt, d-c external power source.

1-56. A start counter is mounted on the gearbox adjacent to the ignition exciter. The counter records the total starts on the engine. It is electrically connected to the power input terminal of the exciter and counts one each time the ignition system is energized. A lead seal provides tamper-proof security.

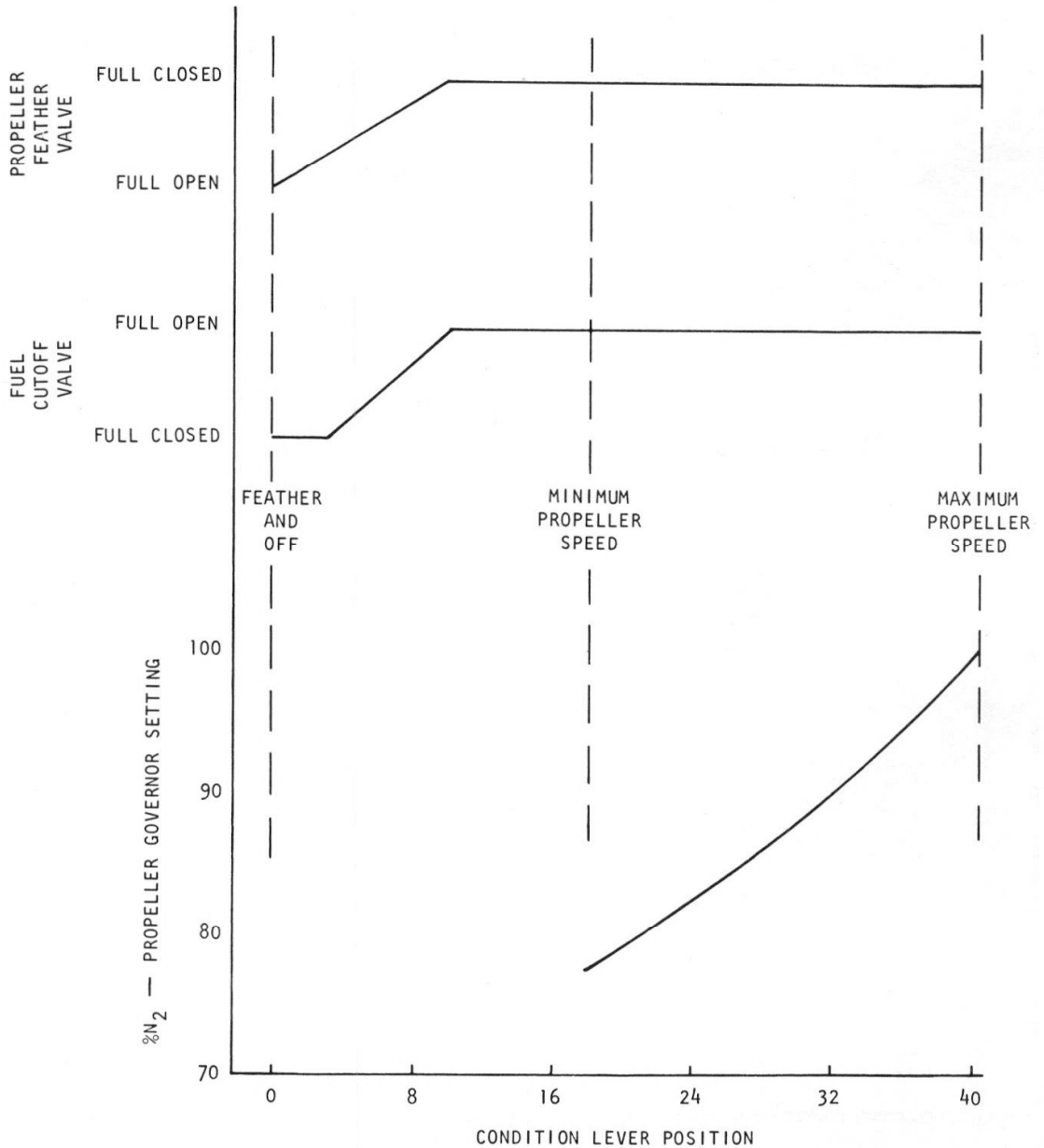


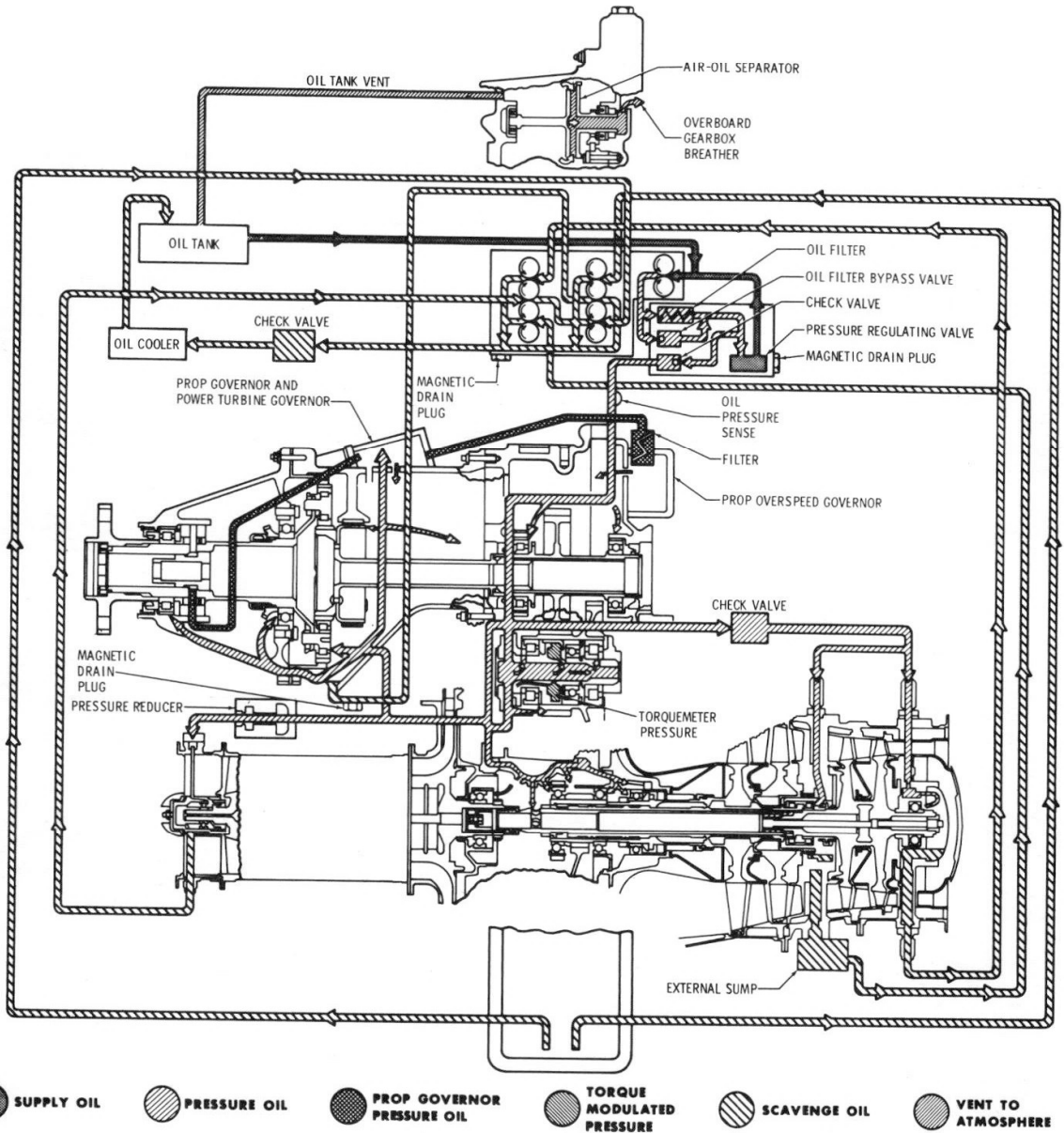
Figure 1-5. Condition Lever Control Schedule

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Figure 1-6. Typical Lubrication System Schematic

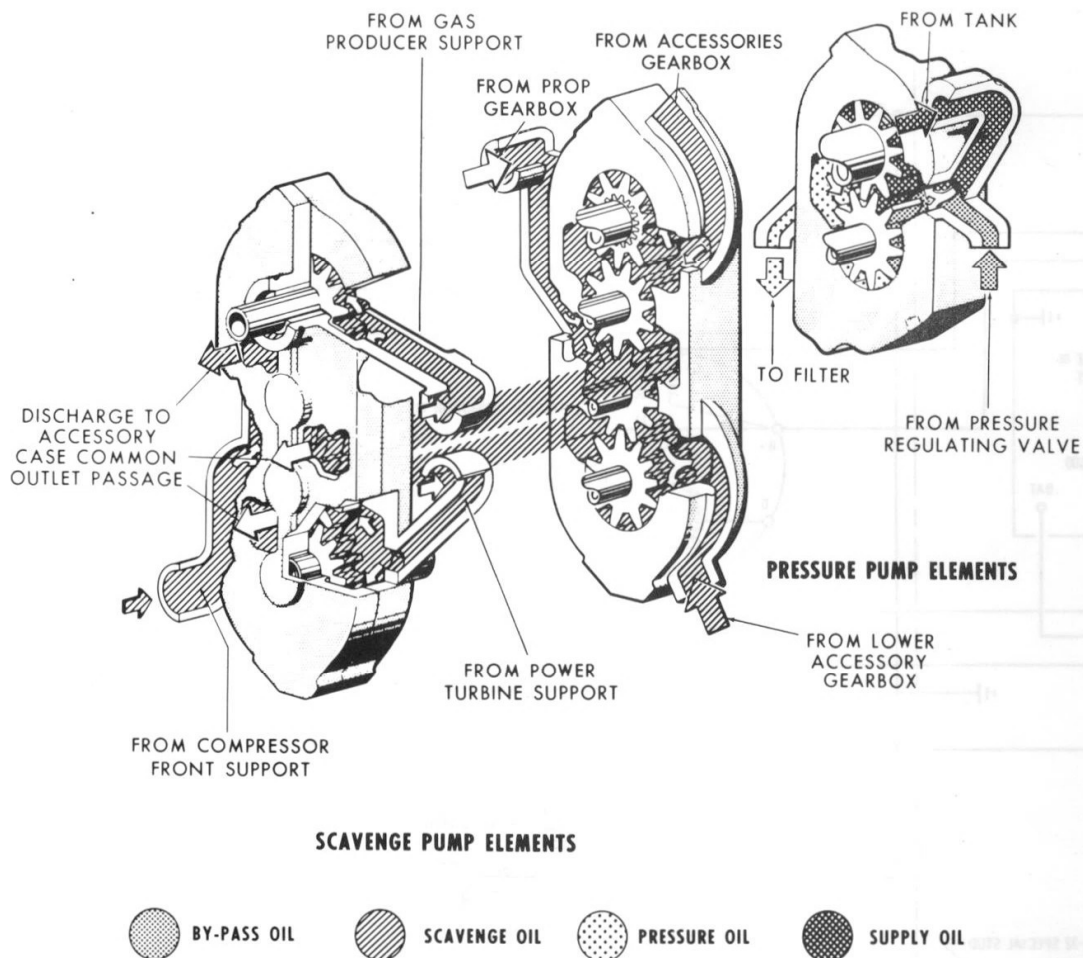


Figure 1-7. Oil Pump Schematic

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**1-57. TEMPERATURE MEASUREMENT SYSTEM.**  
(See figure 1-8.)

1-58. The temperature measurement system consists of four chromel-alumel single junction thermocouples in the gas producer turbine outlet and an associated integral harness. The voltages of the four thermocouples are electrically averaged in the assembly. The airframe temperature indicating system attaches to the integral terminal of the thermocouple assembly.

**1-59. ANTI-ICING SYSTEM**

1-60. The compressor inlet guide vanes and front bearing support hub are the only engine components with anti-icing provisions. Anti-icing is provided by the use of compressor discharge air which is taken from a fitting at the six o'clock position on the front face of the compressor scroll. A manually operated air shutoff valve is mounted in this position to control the anti-icing air.

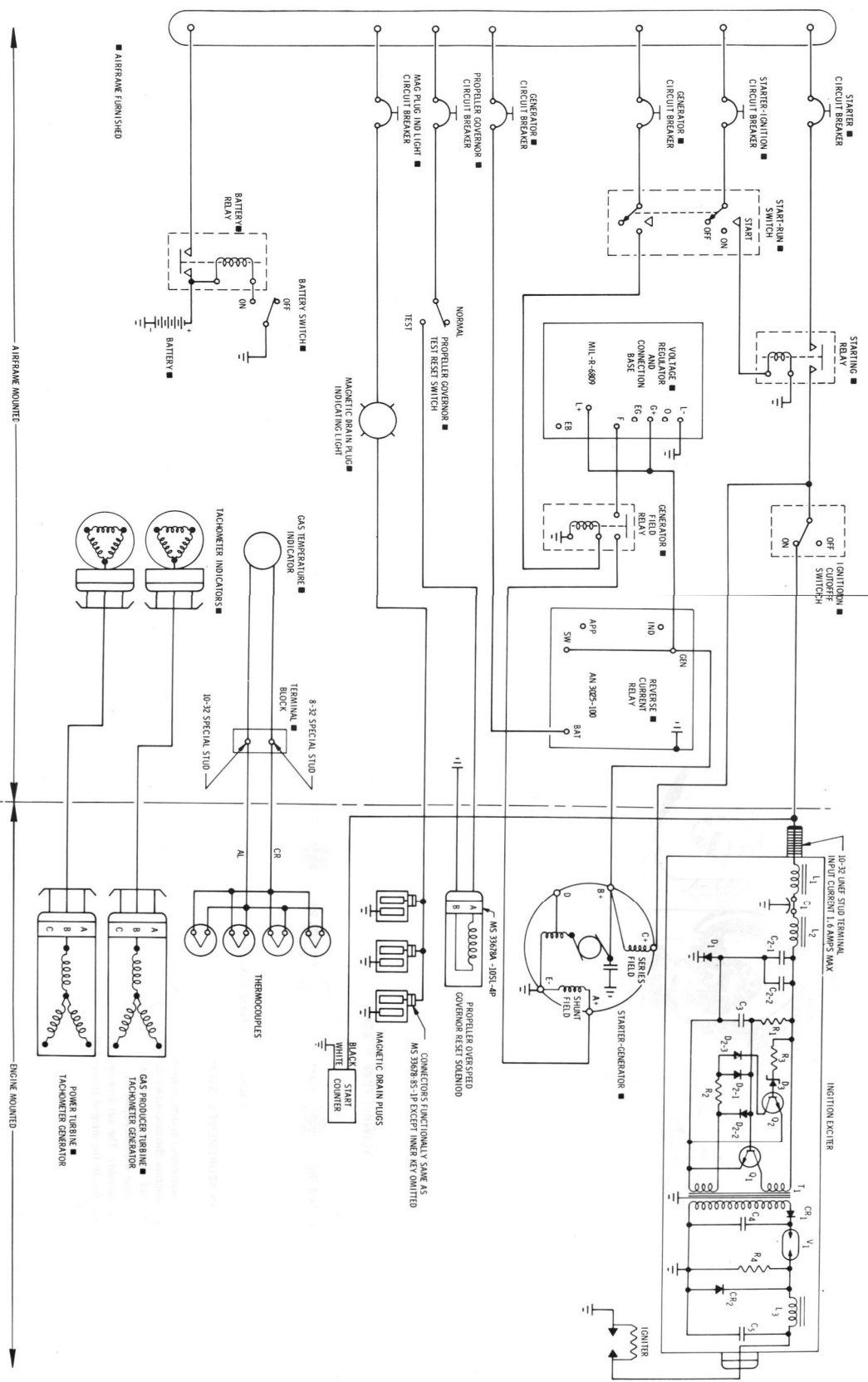


Figure 1-8 Recommended Electrical Wiring Schematic

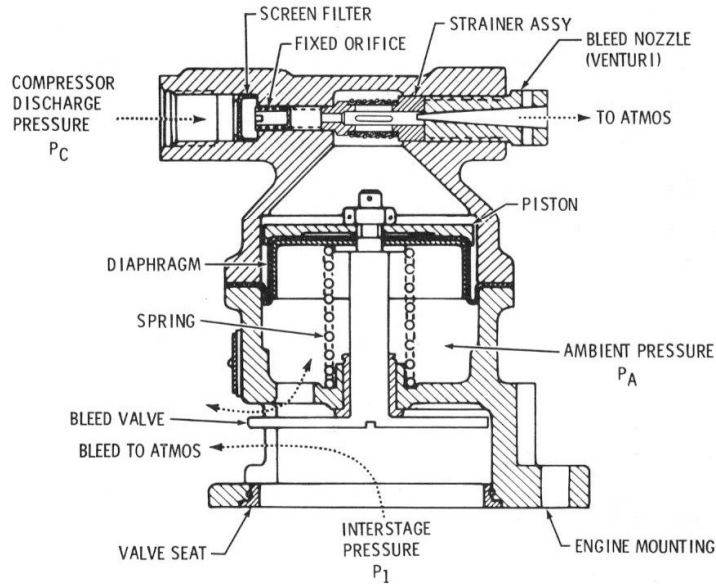


Figure 1-9. Compressor Bleed Control Valve

9166B

1-61. The effect of anti-icing air flow on engine performance is as follows:

Type of Operation	Approximate Effect on Performance Available to Pilot at Power Levels Above 78% (40,000 rpm) $N_1$ Speed*
Constant TOT 777°C (1430°) (Max Continuous)	A 47 hp decrease and a 2.28% (1173 rpm) decrease in $N_1$ speed
Constant $N_1$ Speed 101% (51,490 rpm)	An 11 hp decrease and a 36°C (65°F) increase in TOT
Constant hp (385) and Constant Propeller Speed	A 0.72% (361 rpm) increase in $N_1$ speed and a 48°C (86°F) increase in TOT

\*These values are for Standard Day, Sea Level conditions and will vary with changes in ambient temperature and altitude. The effects at lower powers and speeds will be only slightly different but still immediate and definite.

**1-62. COMPRESSOR BLEED AIR SYSTEM.**

1-63. The compressor bleed air system permits rapid engine response. The system consists of a compressor discharge pressure sensing port on the scroll, tubing from the

sensing port to the bleed valve, a compressor bleed control valve (figure 1-9), and a bleed air manifold on the compressor case.

1-64. An annular slot over the fifth-stage blades bleeds compressor air into a manifold which is an integral part of the compressor case. The manifold forms the mounting flange for the compressor bleed control valve when the compressor case halves are assembled.

1-65. Compressor discharge air pressure sensing, for bleed control valve operation, is obtained at a sensing port on the compressor scroll. The bleed control valve is normally open; it is closed by the compressor discharge pressure. Refer to figure 1-10 for bleed control valve opening and closing speeds.

**1-66. SPECIFICATIONS.**

1-67. The specifications, limits, and performance ratings for the engine are as follows:

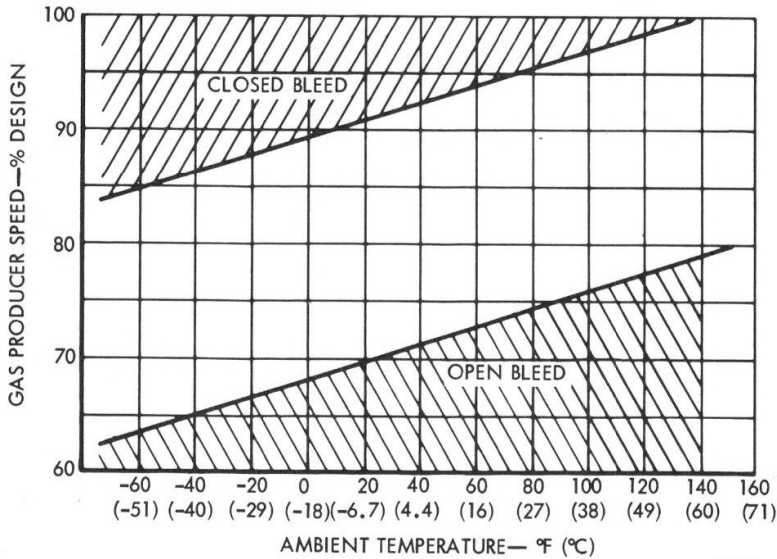
Design power output . . . 400 shp

Design speeds:

Gas producer . . . . . 100% (50,970 rpm)

Power turbine . . . . . 100% (33,290 rpm)

Propeller shaft . . . . . 2030 rpm



15522

Figure 1-10. Compressor Bleed Control Valve Operation

Fuel specification (Refer to 250 TP CSL-1003.)

- Primary . . . . . MIL-T-5624, grade JP-4 and JP-5  
ASTM D-1655, Jet B  
ASTM D-1655, Jet A or A1  
JP-1 fuel conforming to ASTM D-1655, Jet A  
Diesel #1 fuel conforming to ASTM D-1655, Jet A
- Emergency . . . . . MIL-G-5572C, all grades  
(aircraft boost pump on; maximum of 6 hours operation per overhaul period of turbine).

**CAUTION**

MIL-G-5572 fuel containing tricresylphosphate (TCP) additive shall NOT be used.

**Cold Weather**

Operation below 40°F (4°C) requires the use of an icing inhibitor unless the airframe incorporates an anti-icing filter. To assure consistent starts below 40°F (4°C), the following fuels may be necessary:

- MIL-T-5624, grade JP-4
- ASTM D-1655, Jet B
- MIL-T-5624, grade JP-5/  
AVGAS mixture

**NOTE**

The AVGAS-jet fuel mixture is an alternate fuel which may be used if starting problems are encountered in areas where JP-4 or commercial Jet B cannot be obtained. The mixture shall be one part by volume AVGAS to two parts by volume commercial jet fuel. The AVGAS shall conform to MIL-G-5572C, grade 80/87, or grade 100/130 with a maximum of 2.0 ml/gal lead content. Do not use grade 100/130 with 4.6 ml/gal lead content. (The 2.0 ml/gal max lead content, grade 100/130 AVGAS is known as 100L in European areas.) The commercial jet fuel may be kerosene; JP-5 or commercial Jet A conforming to MIL-T-5624, grade JP-5; or ASTM D-1655, Jet A or A1.

**CAUTION**

There is no time limit for engine operation using the AVGAS-jet fuel mixture as long as grade 80/87 AVGAS is used and the 1:2 volume ratio is observed. Use of grade 100/130 (100L) AVGAS-jet fuel mixture shall be restricted to 300 hours in one overhaul period due to the high lead content of the fuel.

TABLE I-1

Performance Ratings—Standard Static Sea Level Conditions—250-B17 Engine

Rating	Equi Shaft Power (est)		Shaft Power (m/h)		Jet Thrust (est)	Gas		Prop Shaft Speed (rpm)	Equip. Specific Fuel Cons. (est)		Specific Fuel Cons (max)		Ram Power Prop Shaft Torque Limit (N·m)	Measured Rated Gas Temp of F (°C)
	hp (kW)	hp (kW)	hp (kW)	lb		Speed-rpm (%) (estimated)	lb/SHPP-hr (mg/W·h)		lb/SHPP-hr (mg/W·h)	lb/SHPP-hr (mg/W·h)				
Takeoff	416 (310)	400 (298)	385 (287)	40	(178)	52,000 (102.0)	2030	0.606 (368.62)	0.630 (383.21)	1088 (1475)	1460 (793)			
Max Cont	401 (299)	385 (287)	346 (258)	39	(173)	51,490 (101.0)	2030	0.609 (370.44)	0.633 (385.04)	996 (1350)	1430 (777)			
Max Cruise	360 (268)	346 (258)	311 (232)	36	(160)	50,200 (98.5)	2030	0.620 (377.13)	0.645 (392.34)	895 (1213)	1358 (737)			
Cruise A	324 (242)	311 (232)	260 (194)	33	(147)	49,180 (96.5)	2030	0.634 (385.65)	0.661 (402.07)	895 (1213)	1301 (705)			
Cruise B	272 (203)	260 (194)	30	30	(133)	47,900 (94.0)	2030	0.667 (405.72)	0.698 (424.58)	895 (1213)	1245 (674)			
Flight Idle	39 (29)	35 est (26 est)	10 max	32,000 (62.8)				75 lb/hr (34.02 kg/hr)	75 lb/hr (34.02 kg/hr)		825 ± 100 (441 ± 56)			

Design speeds: Gas producer rotor—50,970 rpm; power turbine rotor—33,290 rpm; prop shaft—2030 rpm.

Max Cont rating is authorized by the engine manufacturer only for aircraft certification and for emergency use where max continuous power is required.

Max Cruise is the highest power authorized by the engine manufacturer for normal continuous operation.

Cruise A and Cruise B are the power lever positions that provide 90% and 75% respectively of the rated max cruise power at standard sea level static conditions.





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TABLE I-2

Performance Ratings—Normal Operation—250-B17B Engine												
Rating	Shaft Power (min)		Jet Thrust (est)		Gas Producer rpm (est)	Prop shaft rpm	Specific Fuel Cons. (max)		Measured Rated Gas Temp. (Max)		Max Allowable Output Shaft Torque	
	hp	(kW)	lb	(N)			lb/shp-hr	(mg/W-h)	°F	(°C)	ft-lb	(N-m)
<b>Standard Static Sea Level Conditions</b>												
Takeoff (5 min)	400	(298)	39	(173)	51765	2030	0.655	(398.42)	1422	(772)	1087	(1474)
Nor. Cruise	369	(275)	37	(165)	50645	2030	0.656	(399.03)	1360	(738)	955	(1295)
Cruise A	332	(248)	34	(151)	49370	2030	0.670	(407.55)	—	—	955	(1295)
Cruise B	277	(207)	30	(133)	47735	2030	0.715	(434.92)	—	—	955	(1295)
Flight Idle	35 est	(26)	10	(44)	32000	—	75 lb/hr	(34.02 kg/hr)	825	(441)	—	—
									±100	±56		

Specific Fuel Consumption = Fuel Flow/SHP

Nor. Cruise is the highest power ordinarily used in regular cruise operation.

Cruise A and Cruise B are the power levels that are 90% and 75% respectively of the rated Normal Cruise power at standard sea level static conditions.

TABLE I-3

Performance Ratings—One Engine Inoperative and/or Emergency Operation—250-B17B Engine												
Rating	Shaft Power (min)		Jet Thrust (est)		Gas Producer rpm (est)	Prop shaft rpm	Specific Fuel Cons. (max)		Measured Rated Gas Temp. (Max)		Max Allowable Output Shaft Torque	
	hp	(kW)	lb	(N)			lb/shp-hr	(mg/W-h)	°F	(°C)	ft-lb	(N-m)
<b>Standard Static Sea Level Conditions</b>												
Max. Cont.	385	(287)	38	(169)	51220	2030	0.654	(397.81)	1392	(755)	996	(1350)

Max Continuous rating is FAA approved for continuous operation; but is authorized by the engine manufacturer only during one-engine-inoperative (O.E.I.) operation of multi-engine aircraft and emergency operation.





## SECTION II OPERATION

### 2-1. OPERATING PRECAUTIONS.

- 2-2. Observe the following precautions to reduce the danger of personnel injury or damage to the engine.
- Before operating the engine, check the air inlet for foreign objects. (Refer to Compressor Inlet Air Blockage, para 3-56, if operation with inlet blockage is suspected.)
  - If the engine does not operate within the limits of the Operating Limits paragraph, take the designated action.
  - If the aircraft is frequently operated in dusty or sandy areas, periodic erosion inspection is recommended. (Refer to Erosion Inspection, para 3-62.)
  - If a flameout has been experienced as the possible result of snow, ice, or water ingestion, refer to Snow Ingestion Inspection, para 3-60.
  - If the aircraft is being operated following an extended period of inactivity, refer to Special Inspections, table III-6A, for recommended action.
  - If the engine is operated in a salt water environment it must be subjected to a water wash. (Refer to Compressor Salt Water Contamination Removal, para 3-30.)
  - If the installed engine will be shut down for more than five calendar days the compressor must receive an application of preservative. (Refer to Compressor Preservation, para 3-45.)

### 2-3. OPERATING LIMITS.

#### 2-4. ENGINE SPEED.

2-5. If any of the following limits are exceeded, send the designated engine components to repair/overhaul. Record extent of overspeed in the engine log book.

Limit	Component
<b>N<sub>1</sub> (Gas Producer - 250-B17)</b>	
104%—max continuous	None
104-105%—15 sec max	None
104-105%—over 15 sec	Turbine and compressor
over 105%—not allowed	Turbine and compressor
<b>N<sub>1</sub> (Gas Producer - 250-B17B)</b>	
105%—max continuous	None
105-106%—15 sec max	None
105-106%—over 15 sec	Turbine and compressor
Over 106%—Not allowed	Turbine and compressor
<b>N<sub>2</sub> (Power Turbine)</b>	
105%—continuous	None
105-110%—15 sec max	None
105-110%—over 15 sec	Turbine
over 110%—not allowed	Turbine

Limit	Component
Complete loss of prop shaft load	Turbine, accessories gearbox and reduction gearbox
120% or maximum indication shown on N <sub>2</sub> tachometer, whichever is first	Turbine, accessories gearbox and reduction gearbox

### 2-6. TEMPERATURE (TOT).

2-7. Refer to table II-1 or II-1A for the measured gas temperature limits and the action to be taken when they are exceeded.

### 2-8. TORQUE.

2-9. If max torque limit of 450 hp (336 kw) - 1165 ft lbs (1580 N-m) is exceeded for more than 10 seconds, the gearbox must be removed and sent to overhaul. Refer to figure 2-1 for torquesensor oil pressure-to-shaft power relationship and to table II-2 for torque limits.

### 2-10. OIL PRESSURE AND TEMPERATURE.

2-11. If the oil pressure is not within the following limits refer to table III-5, Troubleshooting.

- 94% N<sub>1</sub> speed  
and above . . . . . 120 ± 10 psig  
(827 ± 69 kPa)
- 85-94% N<sub>1</sub> speed . . . . . 90-130 psig  
(621-896 kPa)
- Below 85% N<sub>1</sub> speed . . . . . 50-130 psig  
(345-896 kPa)
- When operating in propeller beta control range the minimum limits can be 15 psig (103 kPa) lower

#### NOTE

During cold weather operation, 150 psig (1034 kPa) main oil pressure is allowable following an engine start. When the 130 psig (896 kPa) limit is exceeded, operate engine at minimum power until normal oil pressure limits are attained.

If the engine has been operated with less than the required oil pressure, except for momentary fluctuation, inspect the oil system in accordance with Low Oil Pressure Operation, para 3-112D.



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TABLE II-1

Measured Gas Temperature Limits (TOT) - 250-B17 Engine

Steady State

Takeoff (5 min. max)	793°C (1460°F)
Max Continuous (certification and emergency only)	777°C (1430°F)
Max Climb	757°C (1394°F)
Max Cruise and Below	737°C (1358°F)

During Starting and Shutdown

<i>Temperature Range</i>	<i>Time</i>	<i>Maintenance Action</i>
Up to 793°C (1460°F)	No limit	None
793-927°C (1460-1700°F)(2)	Over 10 sec	Inspect turbine(1)
927-999°C (1700-1830°F)(2)	Not allowed	Inspect turbine(1)
Over 999°C (1830°F)	Not allowed	Remove turbine for heavy maintenance or overhaul.

NOTE

Refer to item 4, Table III-5 when start temperature consistently exceeds 860°C (1580°F).

During Power Transient

<i>Temperature Range</i>	<i>Time</i>	<i>Maintenance Action</i>
Up to 777°C(1430°F)	No Limit (Transient only)	None
777-793°C(1430-1460°F)	Until stablized (5 min max)	None
793-843°C(1460-1550°F)	0 to 6 sec (Intentional use of temperatures in excess of 793°C is not recommended)	
793-843°C(1460 to 1550°F)	Over 6 sec	Inspect turbine(1)
843-927°C(1550 to 1700°F)	Not allowed	Inspect turbine(1)
Over 927°C(1700°F)	Not allowed	Remove turbine for heavy maintenance or overhaul

(1)Refer to Special Inspections Table III-6A, item 11.

(2)Check Part V of the Engine Log for the part number of the third-stage turbine wheel. If the third stage wheel is P/N 6898551, 6898567, 6898733, 6898743, 6898753 or 6898763, the following overtemperature limits shall apply: 1) 810-927°C (1490-1700°F) for 10 seconds maximum or 2) 927°C (1700°F) peak. If either of these limits are exceeded, record the condition encountered in Part I of the Engine Log. Return these Engine Log pages and the turbine to an Overhaul Agency for replacement of the third-stage turbine wheel.

Note: The time-at-temperature limits are not additive and may be repeated without restrictions.



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TABLE II-1A

Measured Gas Temperature Limits (TOT)—250-B17B Engine

Steady State

Takeoff (5 min.)	810°C (1490°F)
Max Climb	757°C (1394°F)
Nor Cruise and below	737°C (1359°F)

During Starting and Shutdown

Temperature Range	Time	Maintenance Action
Up to 810°C (1490°F)	No limit	None.
810-927°C (1490-1700°F) <sup>(3)</sup>	Over 10 sec	Inspect turbine. <sup>(1)</sup>
927-999°C (1700-1830°F) <sup>(3)</sup>	Not allowed	Inspect turbine. <sup>(1)</sup>
Over 999°C (1830°F)	Not allowed	Remove turbine for heavy maintenance or overhaul.

NOTE

Refer to item 4, table III-5 when start temperature consistently exceeds 860°C (1580°F).

During Power Transient

Temperature Range	Time	Maintenance Action
Up to 779°C (1434°F)	No limit (transient only)	None.
779-810°C (1434-1490°F)	Until stabilized (5 min. max)	None.
810-843°C (1490-1550°F)	0 to 6 sec (intentional use of temperatures in excess of 810°C is not recommended)	None.
810-843°C (1490-1550°F)	Over 6 sec	Inspect turbine. <sup>(1)</sup>
843-927°C (1550-1700°F)	Not allowed	Inspect turbine. <sup>(1)</sup>
Over 927°C (1700°F)	Not allowed	Remove turbine for heavy maintenance or overhaul.

During One Engine Inoperative and/or Emergency Operation

Max Continuous <sup>(2)</sup>	810°C (1490°F)
-------------------------------	----------------

(1) Refer to Special Inspections Table III-6A, item II.

(2) Max continuous is FAA approved for continuous operation; but is authorized by the engine manufacturer only during one-engine-inoperative (OEI) operation of multi-engine aircraft.

(3) Check Part V of the Engine Log for the part number of the third-stage turbine wheel. If the third-stage wheel is P/N 6898551, 6898567, 6898733, 6898743, 6898753 or 6898763, the following overtemperature limits shall apply: 1) 810-927°C (1490-1700°F) for 10 seconds maximum or 2) 927°C (1700°F) peak. If either of these limits are exceeded, record the condition encountered in Part I of the Engine Log. Return these Engine Log pages and the turbine to an Overhaul Agency for replacement of the third-stage turbine wheel.

Note: The time at temperature limits are not additive and may be repeated without restrictions.

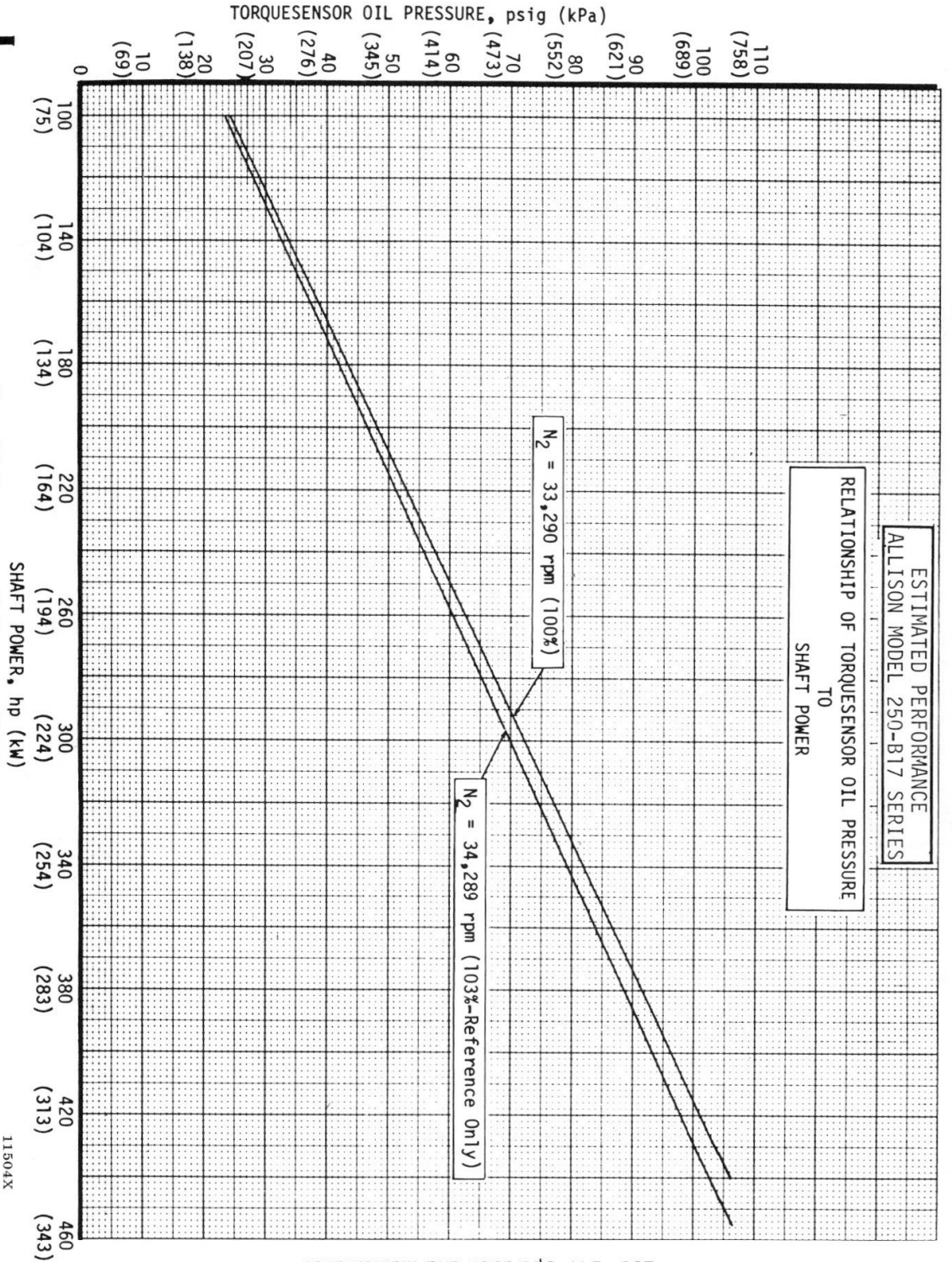


Figure 2.1. Torquesensor Oil Pressure-to-Shaft Power Relationship

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TABLE II-2

**Output (Propeller) Shaft Torque Limits**

Power (100% N <sub>2</sub> )		Torque		T/M Press.		Time Limit
hp	(kW)	lb-ft	(N-m)	psi	(kPa)	
450	(336)	1165	(1580)	109	(752)	10 seconds
420	(313)	1088	(1475)	100	(689)	5 minutes
385	(287)	996	(1350)	93	(641)	Certification and emergency only
375	(280)	970	(1315)	91	(627)	Climb
369	(275)	955	(1295)	90	(621)	Continuous (250-B17B)
346	(258)	895	(1213)	85	(586)	Continuous (250-B17)

Note: All limits except Continuous applicable to both 250-B17 and 250-B17B engines.

2-11A. Oil temperature shall be within the following range. (If the maximum limit is exceeded, refer to Oil Temperature Limit Exceeded, para 3-112A, for corrective action.)

- a. Minimum starting
  - MIL-L-23699 . . . . . -40°F (-40°C)
  - MIL-L-7808 . . . . . -65°F (-54°C)
- b. Maximum
  - Above 40 psi (276 kPa) T/M pressure, 165 hp (123 kW) . . . . . 180°F (82°C)
  - 40 psi (276 kPa) T/M pressure, 165 hp (123 kW), and less . . . . . 225°F (107°C)
- c. Minimum flight operation . . . . . 32°F (0°C)  
(providing engine oil pressure is within the specified limits of para 2-11).

----- NOTE -----

*The oil temperature must be reduced to 180°F (82°C) or less before the engine is operated above 40 psi (276 kPa) T/M pressure or 165 hp (123 kW).*

**2-11B. PRESSURE ALTITUDE AND AMBIENT TEMPERATURE**

2-11C. The engine will start and operate satisfactorily at conditions of ambient pressure and temperature as shown in figure 2-2.

**2-12. OPERATING PROCEDURES.**

----- NOTE -----

*In the operating procedures, Power Lever and Condition Lever are used to identify the aircraft levers used to operate the coordinator Input Power Lever and the coordinator Condition Lever respectively.*

2-13. The procedures which follow pertain to operation of the engine during: Starting, Taxi, Takeoff, Flight, Landing, Shutdown, and Feathering. Before the first flight in any 24 hour period, and when maintenance has been performed on the related parts, check the overspeed function of the overspeed governor. (Refer to Propeller Overspeed Governor Functional Check, para 2-41.)

----- CAUTION -----

*Each time the propeller is serviced with grease, make a brief check run (approx. 5 min.) to be sure grease is not passing through the seal and being ingested into the engine. Wipe all grease from the hub and inlet areas before resuming operation.*





**2-14. GROUND STARTING.**

2-15. Two starting procedures are provided for the engine. The normal starting procedure is for starts in ambient temperatures of 40°F (4°C) and above. (Refer to Normal Start, para 2-16.) The cold weather starting procedure is for starts in ambient temperatures between plus 39°F (4°) and minus 65°F (minus 54°C). (Refer to Cold Weather Starting, para 2-18.)

----- **CAUTION** -----

*Before the engine is operated, make certain the compressor inlet is free of debris. Also, make certain the compressor rotor is not frozen if the aircraft is in a freezing atmosphere.*

**2-16. Normal Starting.**

2-17. Start the engine as follows:

- a. Position the condition lever at FUEL OFF-FEATHER and turn all switches off.
- b. Turn on the aircraft switches required to provide fuel to the engine.

----- **NOTE** -----

*It is recommended that residual TOT be no more than 302°F (150°C) when the throttle is opened and light off is attempted. Residual TOT can be reduced by motoring the engine with the starter. If high ambient conditions are encountered and the TOT cannot be reduced to 150°C, motor the engine until TOT is stabilized before opening the throttle. Closely monitor TOT during the start.*

----- **CAUTION** -----

*During a start, the condition lever must never be moved out of the FUEL OFF-FEATHER position until after the starter and ignition exciter are energized and the desired cranking speed is reached. To do so might result in an explosive lightoff or over-temperature start.*

*Monitor oil pressure during start. Damage to rotor bearings can result if a positive indication of oil pressure is not obtained by the time idle speed is reached.*

- c. Position the power lever at GROUND IDLE.
- d. Energize the starter motor and ignition exciter.
- e. At 15% N<sub>1</sub> speed, move the condition lever to the maximum (100% propeller speed) position.

----- **CAUTION** -----

*The ignition exciter is qualified for continuous duty operation. However, use of the ignition system on a continuous basis is not recommended because of degradation of the spark igniter.*

- f. De-energize the starter and ignition exciter when 58% N<sub>1</sub> speed is reached. The start is completed when a stabilized N<sub>1</sub> speed of 59-65% is reached. Completion of the start normally occurs 15 to 45 seconds after moving the condition lever to the maximum position. A positive indication of oil pressure must be obtained by this point in the start. If it is not, shut down the engine and



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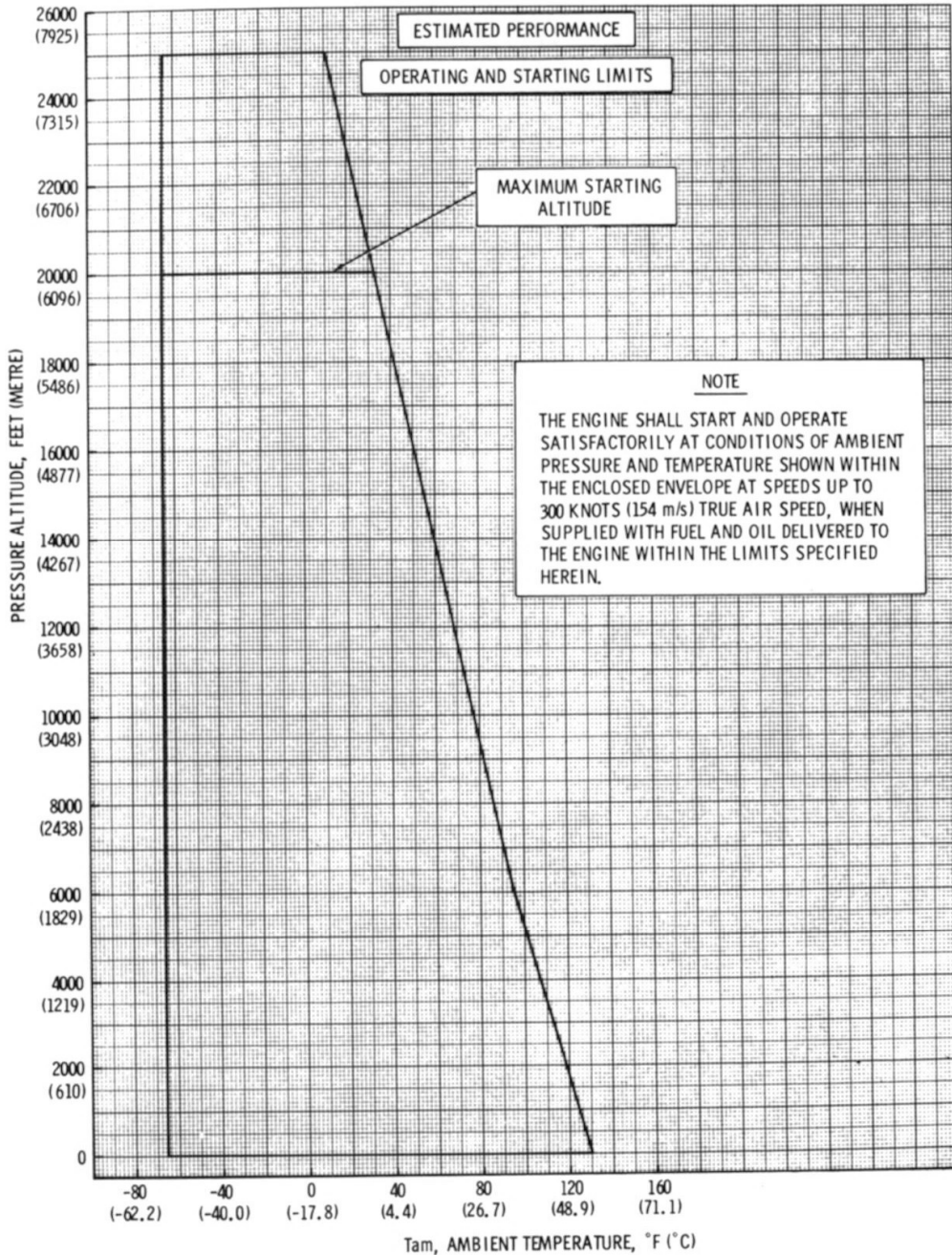


Figure 2-2. Operating and Starting Limits



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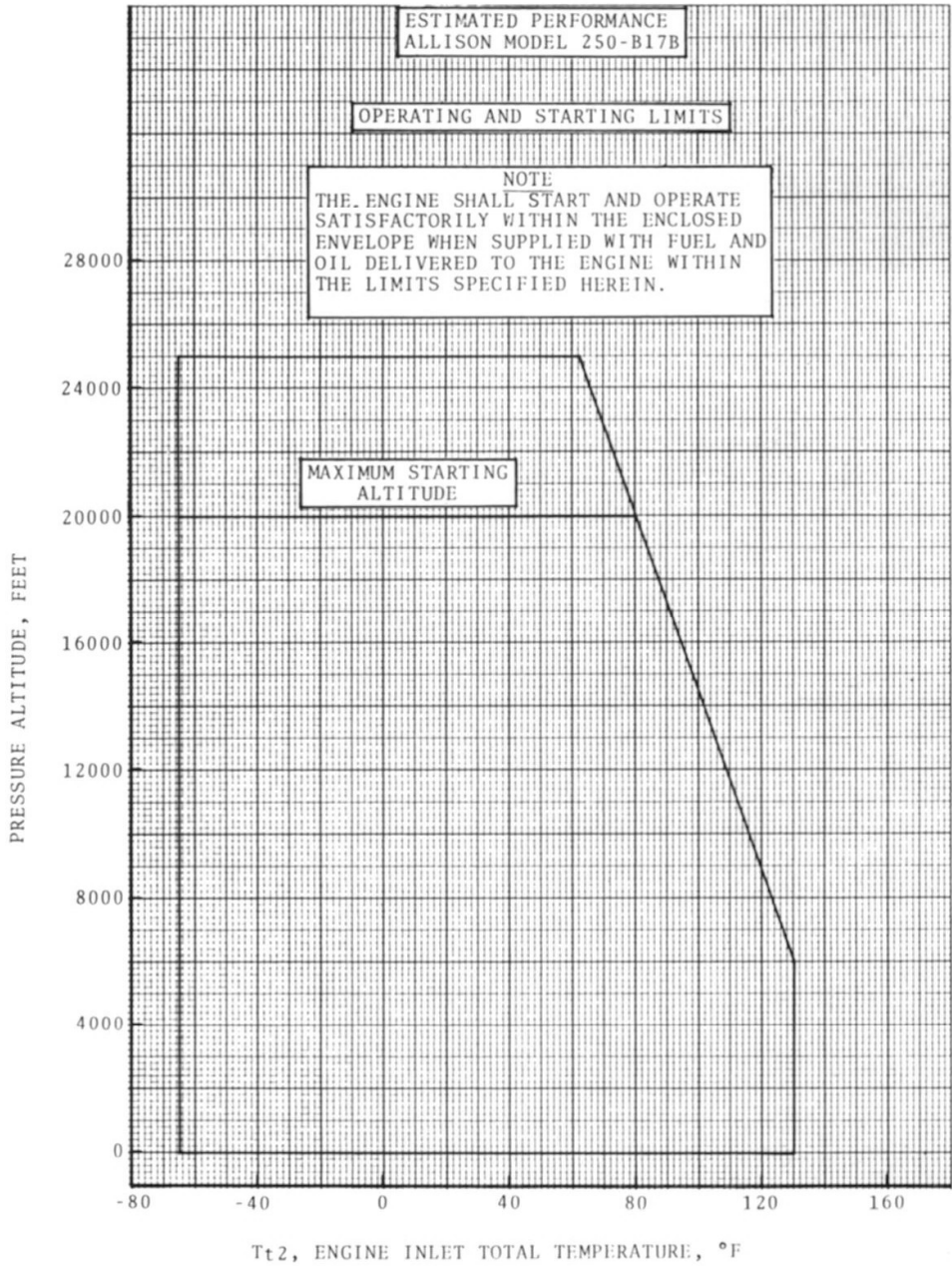


Figure 2-3. Operating and Starting (250-B17B)



check to be sure that oil is available at the power and accessories gearbox inlet. Monitor the measured gas temperature; do not exceed the limits of tables II-1, II-1A or II-2. Propeller unfeathering will automatically occur during the engine start transient.

----- **CAUTION** -----

*If the propeller is not rotating by 25% N<sub>1</sub> speed, abort the start. A second or third start attempt may be made; if the condition still exists refer to item 42 of Troubleshooting table III-5.*

*If propeller unfeathering does not begin by the time N<sub>1</sub> reaches the stabilized speed, shut down the engine.*

g. If the engine has been shut down for more than 15 minutes, stabilize at ground idle speed for one minute before increasing power.

----- **NOTE** -----

*If a false or stagnated start is experienced, shut down; then repeat the start procedure.*

*If overtemperature is experienced during the start, place the condition lever to FUEL OFF-FEATHER and motor the engine without ignition for 10 seconds.*

*The start should be completed in one minute; however, if N<sub>1</sub> and N<sub>2</sub> are accelerating and TOT is within limits, the start may be continued longer than one minute.*

*Maintain a minimum of 64% N<sub>1</sub> rpm when activating the generator.*

**2-18. Cold Weather Starting.**

2-19. Some general practices recommended for improved cold weather operation of the engine are as follows:

a. Use appropriate covers on the inlet duct, exhaust stacks, etc. when the aircraft is parked.

b. At temperatures below 40°F (4°C), use JP-4 commercial Jet B fuel if available. As an alternate use the AVGAS-jet fuel mixture described in Cold Weather Fuels, para 2-43.

----- **NOTE** -----

*Use fuel containing an anti-ice additive whenever engine operations are conducted below 40°F (4°C).*

c. At temperature below 0°F (-18°C), preheat the engine. The fuel control is the primary area for heat application. If a second heat source is available, it should be used to heat the battery.

----- **CAUTION** -----

*Do not use an open flame heater.*

d. If stagnated starts are encountered, enrich the starting fuel flow in accordance with the start derichment adjustment procedure in para 3-82.

e. Use an auxiliary power source whenever possible. If battery starts must be made, the battery should be preheated if it is to do the best possible job of cranking the engine. Preheat the battery to approximately 70°F (21°C)

2-20. Start the engine as follows:

a. Position the condition lever at FUEL OFF-FEATHER and turn all switches off.

b. Turn on the aircraft switches required to provide fuel to the engine.

----- **CAUTION** -----

*During a start, the condition lever must never be moved out of the FUEL OFF-FEATHER position until after the starter and ignition exciter are energized and the desired cranking speed is reached. To do so might result in an explosive lightoff and overtemperature start.*

*Monitor oil pressure during start. Damage to rotor bearings can result if a positive oil pressure indication is not obtained by the time idle speed is reached.*

c. Position the power lever at GROUND IDLE.

d. Energize the starter motor and ignition exciter.

e. At the appropriate N<sub>1</sub> starting speed, move the condition lever to the maximum (100% propeller speed) position. Use the following guide for the appropriate N<sub>1</sub> starting speed.



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$N_1$ rpm	Temp °C (°F)
15%	Above 7° (45°)
13%	-18 to + 7° (0 to 44°)
12%	Below -18° (-1°)

----- **CAUTION** -----  
Do not attempt a start at  $N_1$  speeds below 12%. Starting at  $N_1$  speeds below 12% increases the possibility of exceeding engine temperature limits.  
-----

----- **NOTE** -----  
Variations in jet fuels can affect engine lightoff in cold ambient conditions. The engine may experience a short delay before lightoff after the condition lever is moved to the maximum position. This delay should be less than three seconds regardless of the type of fuel used. If the lightoff delay exceeds three seconds, return the condition lever to FUEL OFF-FEATHER and continue to motor the engine with the starter for thirty seconds to purge unburned fuel from the engine.  
-----

f. De-energize the starter and ignition exciter when 58%  $N_1$  speed is reached. The start is complete when a stabilized  $N_1$  speed of 59-65% is reached. Completion of the start normally occurs 25 to 60 seconds after starter is energized.

----- **CAUTION** -----  
Positive oil pressure must be obtained by the time idle speed is reached. If not obtained, shut down the engine and check to be sure that oil is available at the power and accessories gearbox inlet.

Monitor measured gas temperature. Do not exceed the limits of tables II-1, II-1A or II-2. If overtemperature occurs, move the condition lever to FUEL OFF-FEATHER and continue to motor the engine without ignition for 10 seconds.

If the propeller is not rotating by 25%  $N_1$  speed, abort the start, A second or third start attempt may be made; if the condition still exists, refer to item 42 of Troubleshooting, table III-5.

----- **NOTE** -----  
In some instances,  $N_1$  speed may accelerate slowly through the 25 to 30% speed range. If this occurs, hold the starter engaged for one full minute to assist the engine in completing the start. The

start should be completed in one minute; however, if  $N_1$  and  $N_2$  speeds are accelerating and TOT is within limits, the starter assist may be continued longer than one minute.

-----  
g. If the engine has been shut down for more than 15 minutes, stabilize at idle for one minute before increasing power.

----- **NOTE** -----  
After a cold weather battery start, allow the engine to run at idle speed for two minutes before actuating the generator switch. This will prevent  $N_1$  speed run down resulting from high generator loading.  
-----

**2-21. INFLIGHT STARTING.**

2-22. The inflight starting procedure is the same as for normal ground starting except the power lever must be in the FLIGHT IDLE position.

----- **CAUTION** -----  
Due to thermal changes within the turbine, the gas producer section of the engine may lock up after an inflight shutdown. This is a temporary condition which exists after the engine has been shut down for approximately one minute and which may continue for up to ten minutes following the shutdown. Therefore, except during an emergency, air starts should not be attempted during the time period between one minute after shutdown and ten minutes after shutdown.  
-----

**2-23. TAXI OPERATION.**

2-24. During taxi operation, the gas producer governor regulates the fuel flow and the propeller beta control valve regulates the blade angle. Both the gas producer governor speed setting and the beta control setting are established by the position of the power lever. The propeller governor automatically assumes control of the blade angle when high power levels are selected.

a. The condition lever should be in the position for 100% propeller speed.

b. The power lever can be freely moved to obtain the desired thrust for taxiing.

**2-25. TAKEOFF.**

2-26. During takeoff operation, the gas producer governor regulates the fuel flow and the propeller governor regulates the blade angle position. The speed settings of the gas producer governor and the propeller governor are established by the position of the power lever and the condition lever, respectively.

a. The condition lever should be in the position for 100% propeller speed.



b. Maintain engine power control by using the power lever. The propeller governor will maintain power turbine speed control. Vary the power lever to avoid exceeding the measured gas temperature and torque limits given in tables II-1, II-1A, and II-2.

**2-27. FLIGHT OPERATION.**

2-28. During flight operation, the gas producer governor regulates the fuel flow and the propeller governor regulates the blade angle position. The speed settings of the gas producer governor and the propeller governor are established by the position of the power lever and the condition lever, respectively.

a. Vary the condition lever to establish the desired propeller governor speed setting. The propeller speed setting may be varied between 80 and 100%.

----- **CAUTION** -----

*The condition lever must not be moved below the 80% setting position in flight except for engine shutdown (fuel cutoff and feather). Lower condition lever positions may result in fuel shut-off.*

b. Maintain engine power control by using the power lever. Vary the lever to avoid exceeding the measured gas temperature and torque limits given tables II-1, II-1A, and II-2.

----- **CAUTION** -----

*The power lever must not be moved below the FLIGHT IDLE position during flight operation. Lower lever positions may result in propeller overspeed and excessive drag due to low blade angle or selection of reverse thrust.*

**2-29. LANDING.**

2-30. For descent and landing proceed as follows:

a. Position condition lever at the 100% propeller speed position.

----- **CAUTION** -----

*Use of reverse thrust with the condition lever at less than the 100% position is prohibited. At less than 100% condition lever position,  $N_1$  rpm decay, engine overtemperature, and loss of power can be encountered.*

b. For landing approach the power lever may be retarded to FLIGHT IDLE. Lever movement below FLIGHT IDLE is not permitted during flight operation. (See CAUTION in Flight Operation, para 2-28.)

----- **NOTE** -----

*At low air speeds the propeller blade angle may reach the flight low pitch stop causing power turbine speed to droop below 100%.*

c. After the aircraft is on the ground the power lever may be retarded below FLIGHT IDLE when ground speed is 90 mph IAS or less. Reverse thrust selection is permitted.

----- **CAUTION** -----

*The power lever must not be retarded below FLIGHT IDLE at speeds greater than 90 mph IAS during ground operation.*

----- **NOTE** -----

*During reverse thrust operation, the power turbine governor regulates the fuel flow and the beta control valve regulates the propeller blade angle. The beta control setting is established by the position of the power lever.*

**2-31. GROUND SHUTDOWN.**

2-32. Shut down the engine on the ground as follows:

a. Retard the power lever to the GROUND IDLE position.

b. When the engine has stabilized at Ground Idle move the condition lever to FUEL OFF-FEATHER. The propeller will feather automatically and the engine will shut down.

----- **NOTE** -----

*If the engine has been ground run at high power, maintain the engine at GROUND IDLE for two minutes before shutdown.*

c. Turn off all engine switches.



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**2-33. NORMAL INFLIGHT SHUTDOWN.**

2-34. Make a normal inflight engine shutdown as follows:

- a. Retard the power lever to the FLIGHT IDLE position.

----- **CAUTION** -----

*Do not move the power lever below the FLIGHT IDLE position during flight.*

- b. From the FLIGHT IDLE position move the condition lever to FUEL OFF-FEATHER. The propeller will feather automatically and the engine will shut down.

- c. Turn off all applicable engine switches.

----- **CAUTION** -----

*Do not windmill at 120-125 knots indicated air speed for more than 13 minutes.*

**2-35. EMERGENCY INFLIGHT SHUTDOWN.**

2-36. Make an emergency inflight engine shutdown as follows:

- a. Move the condition lever to FUEL OFF-FEATHER. The propeller will feather automatically and the engine will shut down.
- b. Leave the power lever in the flight range.
- c. Turn off all applicable engine switches.

**2-37. FEATHERING.**

2-38. Propeller feathering is selectable by positioning the condition lever in the FUEL OFF-FEATHER position. Fuel shutoff will occur simultaneously upon selection of FUEL OFF-FEATHER.

**2-39. ANTI-ICING AIR.**

2-40. Consult the aircraft operating manual for the outside air temperature (OAT) at which anti-icing air should be used. If the aircraft manual does not provide this temperature, use anti-icing air when flying into visible moisture at OAT below 5°C (40°F).

**2-41. PROPELLER OVERSPEED GOVERNOR FUNCTIONAL CHECK.**

2-42. Operation of the propeller overspeed governor may be checked as follows:

- a. Position the condition lever at the maximum propeller speed setting.
- b. Advance the power levers to 85% N<sub>2</sub> speed.
- c. Activate the overspeed governor test switches and observe a 3-5% droop in N<sub>2</sub> speed.
- d. Release the overspeed governor test switches; N<sub>2</sub> speed should return to the original setting.

**2-43. COLD WEATHER FUELS.**

2-44. The fuels recommended for consistent cold weather starting (40°F and below) are as follows:

- a. JP-4 (MIL-T-5624)
- b. Jet B (ASTM D-1655)
- c. AVGAS/Jet A, Jet A1, or JP-5 mixture

----- **NOTE** -----

*Jet A, Jet A1, or JP-5 may start the engine at temperatures below 40°F; however, when cold soaked, marginal starts may result due to viscosity changes.*

*Anti-ice additive is required in fuels used at ambient temperatures below 40°F.*

**2-45. MIXING ALTERNATE COLD WEATHER FUEL.**

2-46. The alternate cold weather fuel mixture shall consist of one part by volume AVGAS and two parts by volume commercial jet fuel. The AVGAS shall conform to MIL-G-5572C, grade 80/87 or grade 100/130 with 2.0 ml/gal max lead content. **Do not** use grade 100/130 with 4.6 ml/gal lead content. (The 2.0 ml/gal lead, grade 100/130, AVGAS is known as 100L AVGAS in European areas.) The commercial jet fuel may be kerosene; JP-5 or commercial Jet A conforming to MIL-T-5624, grade JP-5 or ASTM D-1655, Jet A or A1.



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----- CAUTION -----

*There is no time limit for engine operation using the AVGAS-jet fuel mixture as long as 80/87 grade AVGAS is used and the 1:2 volume ratio is observed. Use of 100/130 (100L) grade AVGAS-jet fuel mixture shall be restricted to 300 hours in one overhaul period due to the high lead content of the fuel.*

----- NOTE -----

*Prolonged and uninterrupted operation with only AVGAS mixture will induce lead buildup on turbine parts. This lead buildup can cause a gradual power reduction; consequently, this AVGAS mixture should be used only for cold weather operation. During operation with normal Jet A type turbine fuel, the lead buildup will slowly dissipate.*

a. Make the fuel mix in the aircraft tank. The AVGAS can be added before or after the jet fuel, the only restriction is that the final mix (including fuel in the tank before starting the mix) be two parts by volume jet fuel to one part by volume AVGAS.

----- CAUTION -----

*When mixing the fuels, avoid high flow rates. Do not exceed a flow rate of 50 gallons per minute. Also, make sure the fuel nozzle and fuel tank are grounded to the aircraft.*

----- NOTE -----

*Anti-ice additive is needed for the jet fuel-AVGAS fuel mixture. (Refer to para 1-67.)*

b. The alternate fuel mixture is not recommended for warm weather operation. It is recommended only when the ambient temperature is below 40°F. There is no time limit for engine operation using the AVGAS-jet fuel mixture as long as 80/87 grade AVGAS is used and the 1:2 volume ratio is observed.

c. When the AVGAS-jet fuel mixture is used in the engine the lead from the gasoline accumulates on the turbine and exhaust collector outlet ducts. The normal appearance after operation on leaded fuel is a pale yellow powder deposit on the exhaust surfaces.

----- WARNING -----

*Handling lead residue coated parts by persons with open cuts or scratches on their hands can be extremely dangerous. Always wear gloves when checking residue coated turbine or exhaust parts.*

2-47. In order to obtain a lightoff when the alternate fuel mixture is made in the fuel tank, it may be necessary to: (a) preheat the engine, or (b) bleed the unmixed fuel.

a. Preheat the engine in the area of the fuel control.

----- CAUTION -----

*Do not use an open flame heater to preheat the engine.*

b. Bleed the unmixed fuel from the system as follows:

----- CAUTION -----

*Post fire protection before opening the fuel line.*

- (1) Deactivate the igniter circuit breaker.
- (2) Disconnect the fuel line at the fuel nozzle.
- (3) Place the fuel line in a container. Observe caution to keep contaminants from entering the exposed fuel passage.
- (4) Place the power lever at TAKEOFF.
- (5) Turn on the aircraft switches required to provide fuel to the engine.
- (6) Move the condition lever to the maximum (100% propeller speed) position.
- (7) Energize the starter and motor the engine without ignition and flow fuel from the fuel line until the unmixed fuel has drained and the AVGAS mixture appears. The AVGAS mixture can be visually detected because it is light pink in color.
- (8) Discontinue motoring and move the condition lever to the FUEL OFF-FEATHER position.
- (9) Turn off all engine switches.
- (10) Reconnect the fuel line to the fuel nozzle. Tighten the coupling nut to 80-120 lb in.



## SECTION III MAINTENANCE

### 3-1. GENERAL.

3-2. This section describes the maintenance requirements of the engine. Maintenance functions are grouped by component assembly or by system of the engine to which they are related.

3-3. Some general maintenance practices which do not apply to one specific system or component are included in addition to a listing of special tools required at the maintenance level.

3-4. Use engine turnover stand 6795579 to support an engine removed from the airframe for maintenance. Before removing an engine from the airframe, remove, clean, and reinstall the fuel control-to-governor P<sub>y</sub> tube (P/N 6853435). If the engine is inverted (as in the turnover stand) before the residual oil has been removed from the P<sub>y</sub> tube, this oil will enter and contaminate the fuel control.

### 3-5. SPECIAL SERVICE TOOLS.

3-6. The special service tools required for engine maintenance are as follows: (Figure reference letters pertain to figure 3-1.)

<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>
6795579	Stand—Turnover, Engine Assembly Used to hold, support and rotate the engine assembly for installation and removal of components.	<b>A</b>
6795590	Puller—Bearing, Gas Producer Turbine, Power Turbine and Compressor Used to remove the power turbine ball bearing and mating ring seal.	<b>B</b>
6795597	Wrench—Spanner, Torquemeter Shaft and Shaft Support Nuts Used for installation and removal of the spanner nuts on the torquemeter shaft support and support shaft. Used with 6795974 fixture.	<b>3-47B</b>
6795614	Puller and Pusher—Idler Gear Support Shaft, Power and Accessories Gearbox Used to install and remove the idler gear support shafts.	<b>3-47J</b>
6795969	Holder—Torquemeter Shaft Support Used to install and remove the torquemeter shaft support and bearing at the power and accessories gearbox cover.	<b>3-47U</b>
6795974	Fixture—Aligning, Torquemeter Support Shaft Used to hold and align the torquemeter support shaft while removing and installing the torquemeter support shaft nut. Used with 6795597 wrench.	<b>3-47M</b>
6795984	Holder—Power Turbine Shaft Used to hold the power turbine shaft during installation and removal of the power turbine shaft ball bearing retaining nut. Used with 6795985 wrench.	<b>C</b>
6795985	Wrench—Power Turbine Shaft Ball Bearing Retaining Nut Used to install and remove the power turbine shaft ball bearing retaining nut. Use with 6795984 holder.	<b>D</b>
6796918	Drift—Installation, Turbine and Exhaust Collector Support Oil Bellows Seal Used to install and guide the oil bellows seal into the turbine and exhaust collector support.	<b>E</b>
6796920	Puller—Oil Jet, Gas Producer Bearing Used to remove or install the gas producer ball bearing oil jet tube in the gas producer support.	<b>F</b>



<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>	<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>
6796922	Pusher—Installation, Power Turbine Ball Bearing Used to install the ball bearing on the power turbine shaft; used with guide (-2) from 6796918 guide.	G		torquemeter shaft support roller bearing. Used with 6796950 bearing removal plate or 6796930 bearing installation plate.	
6796930	Plate—Installation, Power and Accessories Gearbox Bearings Used to install the following bearings on their respective shafts: power turbine governor and tachometer, gas turbine idler, oil pump idler, torquemeter support, torquemeter shaft support, torquemeter piston, power turbine takeoff, gas turbine fuel control, starter drive, accessories drive and fuel control drive. Used with 6796946, 6796947, 6796948, and 6796949 drifts.	W	6796948	Drift—Installation and Removal, Power and Accessories Gearbox Power Turbine Drive Bearings Used to install or remove the power turbine takeoff drive shaft bearing and to remove the power turbine main drive pinion bearing. Used with 6796950 bearing removal plate or 6796930 bearing installation plate.	Z
6796941	Kit—Installation and Removal, Oil Seal Used to install and remove lip-type oil seals in the power and accessories gearbox.	H	6796949	Drift—Installation, Power and Accessories Gearbox Bearings Used to install the following bearings on their respective shafts: gas turbine fuel control, starter drive, accessories drive and fuel pump drive. Used with 6796930 bearing installation plate.	AA
6796946	Drift—Installation and Removal, Power and Accessories Gearbox Bearings Used to install or remove the following bearings: power turbine governor and tachometer shaft, gas turbine idler shaft and oil pump idler shaft. Used to remove the following bearings: gas turbine fuel control shaft, starter drive shaft, accessory drive shaft and fuel pump drive shaft. Used with 6796950 bearing removal plate or 6796930 bearing installation plate.	X	6796950	Kit—Puller, Power and Accessories Gearbox Bearing Removal Used to remove the following bearings from their respective shafts: power turbine governor and tachometer, gas turbine idler, oil pump idler, gas turbine fuel control, starter drive, accessory drive, fuel pump drive, torquemeter piston, torquemeter support, torquemeter shaft support, power turbine takeoff drive and power turbine main drive pinion. Used with 6796946, 6796947, or 6796948 drifts.	AB
6796947	Drift—Installation and Removal, Power and Accessories Gearbox Torquemeter Bearings Used to install or remove the torquemeter piston ball bearing, torquemeter support shaft roller bearing, and	Y	6796952	Puller—Forward Bearing and Seal Follower Used to remove ball bearing and mating ring seal from the first-stage compressor wheel.	



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<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>	<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>
6796966	Pliers—Retaining Ring, Fuel Control Drive Bearing Used to collapse the snap ring retaining the fuel control drive gear and bearing assembly during installation or removal.	<b>3-47F</b>	6798926	Crimper—Locknut, Gas Producer First-stage Wheel Used to crimp lock portion of gas producer rear bearing spanner nut into slot of first-stage turbine wheel.	—
6798261	Lift—Engine Assembly Used to lift the engine assembly.	<b>I</b>	6798927	Crimper—Locknut, Compressor Impeller Assembly and Turbine Power Shaft Used to crimp lock portion of spanner nut into spherical radius of shaft.	—
6798045	Wrench—Holding, Gas Producer Turbine Used to support and hold the gas producer rotor while removing the first-stage turbine nozzle.	<b>J</b>	6798928	Protector—Power Turbine Oil Bellows Seal Puller Used to protect oil bellows seal face when removing oil bellows seal assembly. Used with 6799973.	—
6798046	Wrench—Bearing Locknut, Gas Producer Used to remove or install the gas producer turbine ball bearing locknut. Use with 6798045 wrench.	<b>K</b>	6799518	Puller—Gas Producer Ball Bearing Labyrinth Seal Assembly Used to remove the ball bearing and oil seal from the gas producer turbine support.	<b>P</b>
6798047	Wrench—Oil Sump, Turbine Used to remove or install the oil sump and nut assembly.	<b>L</b>	6799700	Puller—Vibration Damper, Front Compressor Bearing Used to remove the front compressor bearing vibration damper from the bearing housing.	<b>3-35B</b>
6798089	Adapter—Supporting, Turbine Unit Assembly Used to support the turbine assembly when removing the first-stage turbine nozzle or the oil bellows seal.	<b>M</b>	6799790	Adapter—Turning, Engine Used to turn the compressor rotor when machining out the blade tip path in the plastic coating of a replacement compressor case.	<b>Q</b>
6798292	Wrench—Ground Idle Adjusting Used to adjust idle speed.	<b>N</b>	6799952	Clamp—Installation, Compressor Discharge Air Tube-to-Outer Combustion Case Used to compress the steel seal ring when installing the compressor discharge air tube in the combustion outer case.	<b>R</b>
6798316	Adapter—Turnover Stand Replaces detail -7 on stand 6795579	<b>O</b>	6799953	Clamp—Installation, Compressor Discharge Air Tube-to-Compressor Scroll Used to compress the steel seal ring when installing the compressor discharge air tube in the diffuser scroll.	<b>S</b>
6798787	Fixture—Compressor Discharge Air Tube Assembly Pressure Check Used to pressure test discharge air tube.	—			
6798796	Drift—Vibration Damper, Compressor Front Bearing Used to press compressor front bearing vibration damper into bearing housing,	—			
6798807	Compressor—Lube Oil Filter Poppet Valve Used to install poppet valve in filter housing.	—			

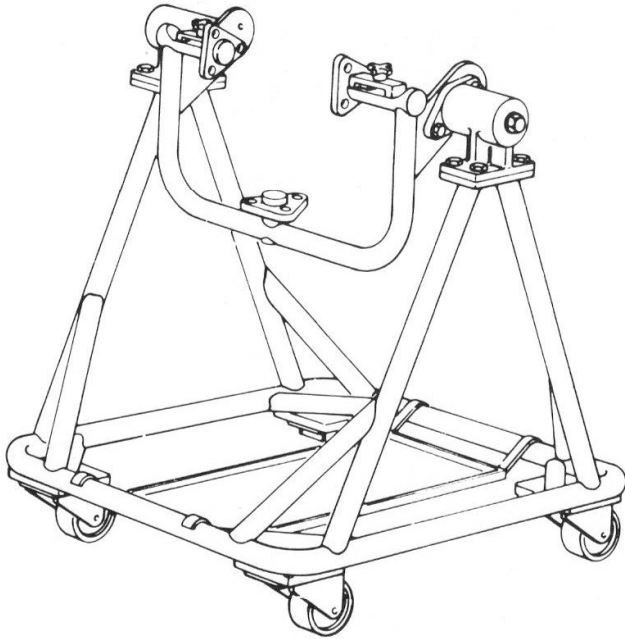


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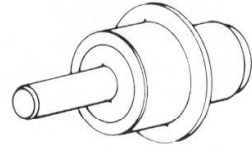
<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>	<i>Tool No.</i>	<i>Description</i>	<i>Figure Reference</i>
6799955	Fixture—Assembly Turbine Used to hold and support the gas producer turbine support.	—	6872927	Wrench—Gearbox Flanged Studs Used to install or remove gearbox studs at compressor mounting location.	—
6799973	Puller—Seal, Power Turbine Bellows Used to remove oil bellows seal from the turbine and exhaust collector support.	U	6886201	Guide—Power Takeoff Roller Bearing Used to guide power takeoff shaft through the forward roller bearing during assembly of gearbox housing to cover.	3-47V
6872165	Gage—Internal Clearance, Helical Drive Gear Used to check internal clearance of ball bearings after assembly to helical drive gear.	—	6886204	Kit—Protector, Compressor Cleaning Used to cap pressure probe elbows and bleed valve sensing lines and to hold bleed valve in closed position during compressor cleaning.	—
6872575	Pin—Rigging, Coordinator Lever Used to rig the propeller governor control cable.	V	6893535	Compressor—Removal, Retaining Ring, Carbon Seal Used to compress the compressor front bearing seal retainer.	—
6872646	Guide—Bearing, Spur Adapter Gearshaft Used to remove or install the compressor assembly.	3-37	6895538	Press—Gas Producer Turbine Rotor and Bearing Used to remove the gas producer turbine rotor from the turbine support. Also used to install the gas producer rear bearing and seal in the gas producer turbine support.	T
6872746	Puller—Power Train Drive Gear Bearing Used to remove bearings from forward and aft ends of power train drive gear.	—	T26927	Wrench (Bendix) Used to remove or install the P <sub>y</sub> bleed on fuel control.	W
6872879	Kit—Spotfacing Used to machine compressor mounting inserts in the gearbox to required height.	—	23002204	Gage—No Go, Starter Generator Gearshaft Spline Used to detect starter generator shaftgear splines that are worn beyond maintenance wear limits.	—
6872880	Fixture—Checking Used to check height of compressor mounting inserts in the gearbox.	—	23002215	Wrench—Fuel Injector Used to remove or install the fuel nozzle.	—
6872881	Wrench—Insert Used to remove or install compressor mounting inserts in the gearbox.	—			



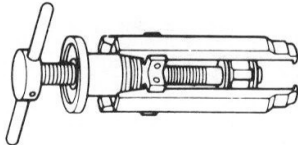
**A** STAND 6795579



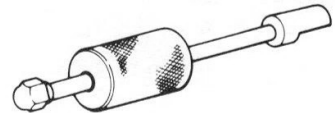
**D** WRENCH 6795985



**E** DRIFT 6796918



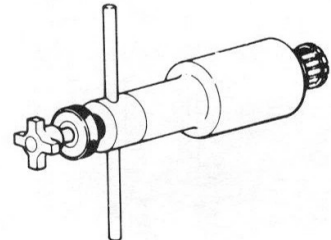
**B** PULLER 6795590



**F** PULLER 6796920



**C** HOLDER 6795984



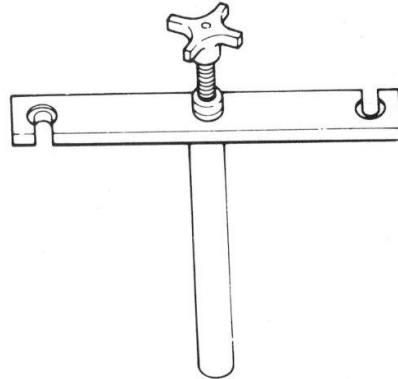
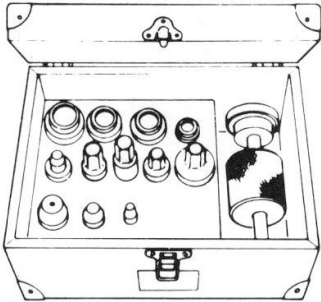
**G** PUSHER 6796922

Figure 3-1. Maintenance Tools (Sheet 1 of 6)



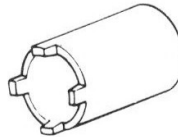
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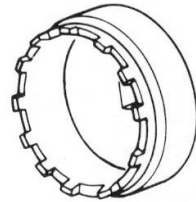


**J** WRENCH 6798045

- | <i>Detail</i> | <i>Name and Application</i>  |
|---------------|--|
| 6796941-200   | Puller—Tachometer  |
| -201          | Puller—Fuel Pump, Accessory Drive, Fuel Control, Governor, and Starter |
| -202          | Puller—Power Takeoff   |
| -203          | Handle Assembly  |
| -12           | Puller—Idler Gears   |
| -13           | Guide—Tachometer   |
| -14           | Guide—Fuel Pump, Accessory Drive, Fuel Control, Governor, and Starter  |
| -15           | Guide—Helical Power Train Drive  |
| -16           | Installation Tool—Tachometer   |
| -17           | Installation Tool—Fuel Pump, Spare, Fuel Control and Governor          |
| -18           | Installation Tool—Starter  |
| -19           | Installation Tool—Power Takeoff  |
| -20           | Installation Tool—Gas Producer Gear Train Idler Spur Gear              |

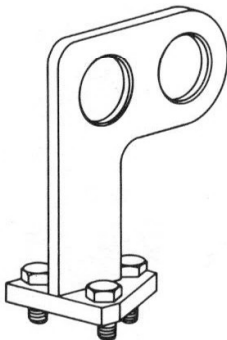


**K** WRENCH 6798046

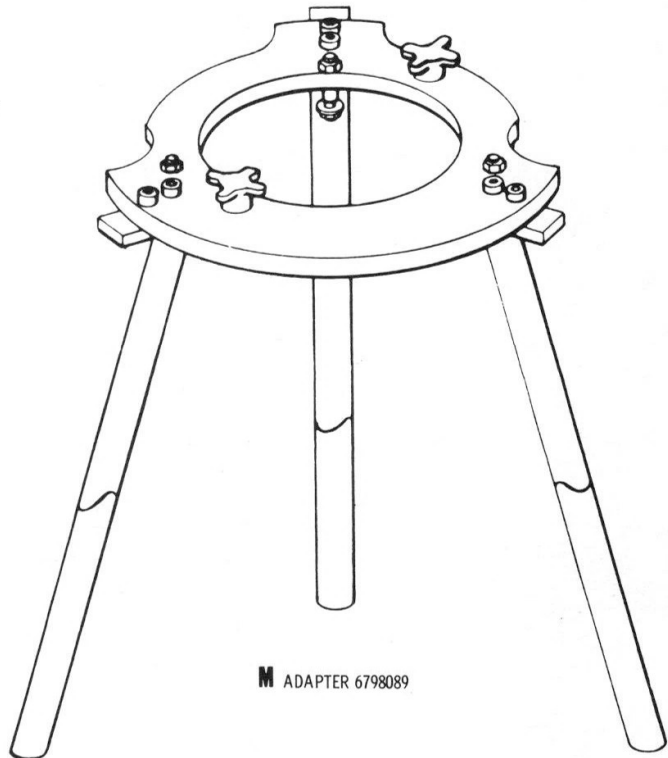


**L** WRENCH 6798047

**H** SEAL KIT 6796941



**I** LIFT 6798261



**M** ADAPTER 6798089

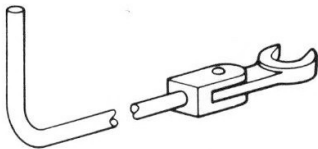
Figure 3-1. Maintenance Tools (Sheet 2 of 6)



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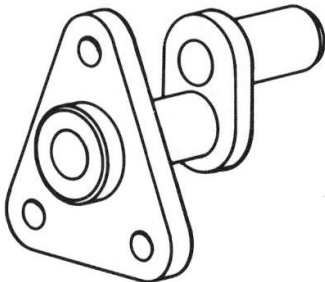
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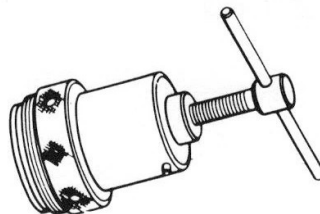
**N** WRENCH 6798292



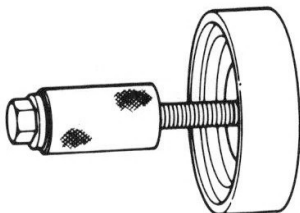
**S** CLAMP 6799953



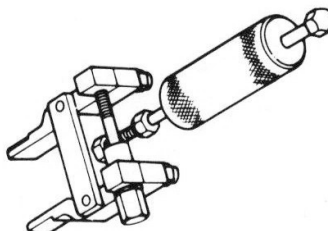
**O** ADAPTER 6798316



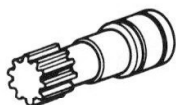
**T** PRESS 6895538



**P** PULLER 6799518



**U** PULLER 6799973



**Q** ADAPTER 6799790

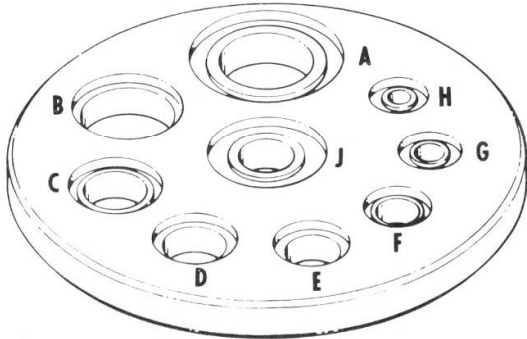


**V** PIN 6872575



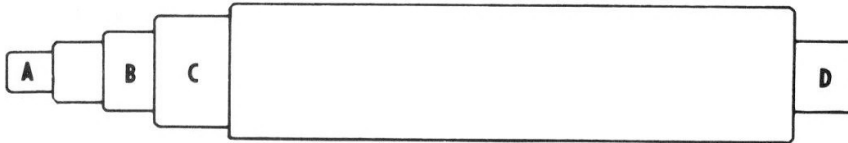
**R** CLAMP 6799952

Figure 3-1. Maintenance Tools (Sheet 3 of 6)



LOCATION	BEARING INSTALLATION APPLICATION
A	HELICAL POWER TAKEOFF GEARSHAFT
B	HELICAL POWER TAKEOFF GEARSHAFT (HOUSING END)
C	STARTER GENERATOR SPUR GEARSHAFT, FUEL PUMP DRIVE SPUR GEARSHAFT, TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (COVER END), FUEL CONTROL SPUR GEARSHAFT
D	TORQUEMETER SUPPORT SHAFT (HOUSING END)
E	TORQUEMETER SHAFT SUPPORT
F	FUEL PUMP DRIVE SPUR GEARSHAFT (COVER END)
G	TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (HOUSING END)
H	GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT (HOUSING END) FUEL CONTROL AND OIL PUMP SPUR GEARSHAFT
J	TORQUEMETER PISTON

W PLATE 6796930



DIAMETER	APPLICATION
A	TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (HOUSING END) GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT (HOUSING END) FUEL CONTROL AND OIL PUMP SPUR GEARSHAFT
B	FUEL CONTROL SPUR GEARSHAFT (REMOVAL) STARTER GENERATOR SPUR GEARSHAFT (REMOVAL) ACCESSORY DRIVE SPUR GEARSHAFT (REMOVAL) TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (COVER END)
C	FUEL PUMP DRIVE SPUR GEARSHAFT (REMOVAL)
D	GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT (COVER END)

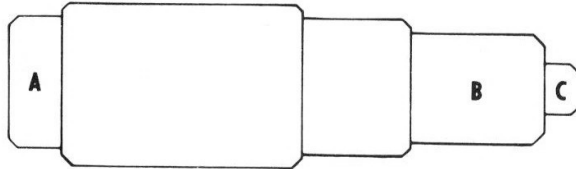
X DRIFT 6796946

Figure 3-1. Maintenance Tools (Sheet 4 of 6)



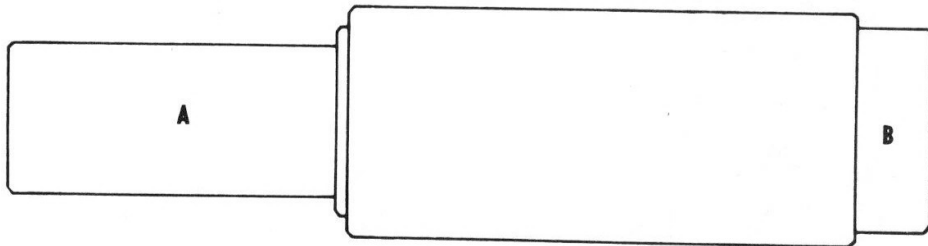
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<u>DIAMETER</u>	<u>APPLICATION</u>
<b>A</b>	TORQUEMETER SUPPORT SHAFT (REMOVAL)
<b>B</b>	TORQUEMETER PISTON TORQUEMETER SHAFT SUPPORT (INSTALLATION)
<b>C</b>	TORQUEMETER SUPPORT SHAFT (INSTALLATION)

**Y** DRIFT 6796947



<u>DIAMETER</u>	<u>APPLICATION</u>
<b>A</b>	HELICAL POWER TRAIN DRIVE GEAR
<b>B</b>	HELICAL POWER TAKEOFF GEARSHAFT

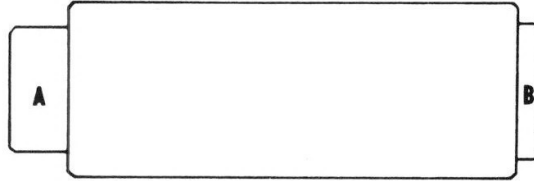
**Z** DRIFT 6796948

Figure 3-1. Maintenance Tools (Sheet 5 of 6)

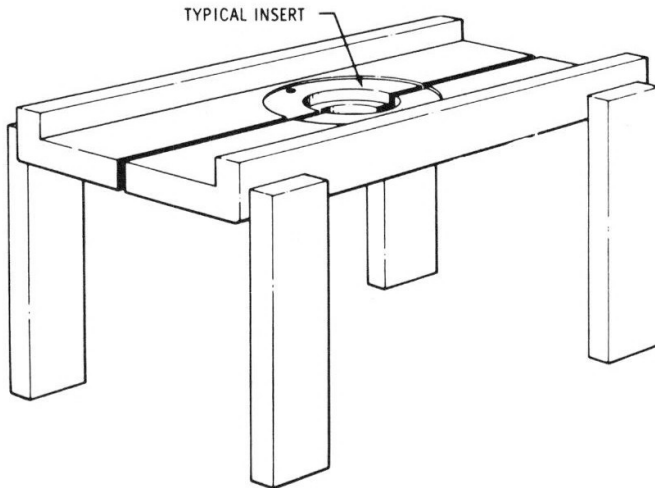


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<u>DIAMETER</u>	<u>APPLICATION</u>
<b>A</b>	FUEL CONTROL SPUR GEARSHAFT
<b>B</b>	STARTER GENERATOR SPUR GEARSHAFT ACCESSORY DRIVE SPUR GEARSHAFT FUEL PUMP DRIVE SPUR GEARSHAFT
<b>AA</b>	DRIFT 6796949



<u>INSERT DETAIL NO.</u>	<u>BEARING PULLER APPLICATION</u>
6796950-4	TORQUEMETER SUPPORT SHAFT ROLLER BEARING INNER RACE
-5	TORQUEMETER SHAFT SUPPORT ROLLER BEARING INNER RACE
-6	TORQUEMETER PISTON
-7	TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (HOUSING END), AND GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT
-8	GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT (COVER END)
-23	HELICAL POWER TRAIN DRIVE GEAR
-10	HELICAL POWER TAKEOFF GEARSHAFT ROLLER BEARING INNER RACE
-11	HELICAL POWER TAKEOFF GEARSHAFT BALL BEARING
-12	TACHOMETER AND GOVERNOR POWER TRAIN SPUR GEARSHAFT (COVER END), FUEL CONTROL AND OIL PUMP SPUR GEARSHAFT (COVER END), FUEL PUMP DRIVE SPUR GEARSHAFT, ACCESSORY DRIVE SPUR GEARSHAFT, AND STARTER GENERATOR SPUR GEARSHAFT
-13	FUEL CONTROL AND OIL PUMP SPUR GEARSHAFT (HOUSING END), GAS PRODUCER GEAR TRAIN IDLER SPUR GEARSHAFT (HOUSING END)
-14	FUEL CONTROL AND OIL PUMP SPUR GEARSHAFT (COVER END)
<b>AB</b>	<b>KIT 6796950</b>

Figure 3-1. Maintenance Tools (Sheet 6 of 6)



### 3-7. GENERAL PRACTICES.

3-8. Some of the general practices applicable to engine maintenance follow.

----- **CAUTION** -----

*When the gas producer fuel control or propeller-power turbine governor are removed from the engine, use extreme care to prevent foreign materials from entering the pneumatic lines or the ports of the component.*

*During oil servicing or any other maintenance, use care to ensure that no metal chips, particles, or debris of any kind is allowed to enter the engine oil system.*

*Use plastic or rawhide hammer heads—never metal—when driving on any part of the engine. Never use pliers on nuts and bolts.*

*When marking or identifying any part subjected to high temperatures, do not use any marking material containing graphite. (See table III-1.)*

*The compressor-to-turbine coupling shaft is a nitrided part and is susceptible to handling damage. Any handling damage can result in crack propagation. If the coupling is dropped it must be processed by an authorized overhaul shop prior to further service.*

-----

### 3-9. CONSUMABLE MATERIALS.

3-10. Refer to table III-1 for a summary of consumable materials used to maintain the engine. The Acceptable Source column of the table lists only one supplier for each item; any equivalent product is acceptable. In determining whether or not an item is equivalent, the burden of proof rests with the operator and his supplier, not with the Detroit Diesel Allison Division.

### 3-11. HARDWARE.

3-12. Use 0.020 in. diameter stainless steel lockwire MS20995-C20 where lockwire size is not specified. Double strand lockwire all drilled bolts, plugs, and screws, except those locked with self-locking nuts or lock-washers. Lockwire bolts in pairs where possible. When reassembling, be sure to safety wherever lockwire was removed. Do not use zinc lockwire. Do not reuse lockwire, cotter pins, ring seals, lip seals, composition gaskets, and split or tab washers. Self locking nuts can be reused if they have a minimum prevailing torque within the limits given in table III-2.

### 3-13. TORQUES.

3-14. The following paragraphs contain general torque limits for tightening nuts, bolts, and screws. (See table III-3). Torque limits for special applications are provided under maintenance for the specific component. Reuse self-locking nuts having a minimum prevailing torque within the limits given in table III-2. When the tightening procedure calls for locknut drag to be added to a given torque value, obtain the drag as follows:

- a. Tighten the nut snug.
- b. Back off one half turn.
- c. Locknut drag is the torque required to first turn the loosened nut.

3-15. Tighten without the use of a thread lubricant unless one is specified. Threads must be free of burrs or nicks, and they must turn freely. Complete tightening at the first draw-down causes overstressing of parts and distorted splitlines. On bolt circles, alternately tighten nuts, bolts, or screws that are 180° apart to half of minimum torque. Repeat the process, tightening to specified torque. On splitlines other than bolt circles tighten midsection nuts, bolts, or screws first to half minimum torque; then tighten remaining threaded parts to half minimum torque. Repeat the process, tightening to specified torque.



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TABLE III-1

Summary of Consumable Materials

<i>Material</i>	<i>Usage</i>	<i>Acceptable Source</i>
Engine Oil	Lubricate bearings, O-rings, etc.	See 250 CSL-1002.
Lubricant	Lubricate accessory splines	Lubriplate 130A. Fiske Brothers Refining Co. 129 Lockwood Newark, New Jersey 07105
Grease	• Seal and bearing installation	No. 6249 (MIL-G-23827). Shell Oil Co. Shell Building Houston, Texas 77002
	Starter generator gearshaft splines	Aeroshell No. 22 (MIL-G-81322). Shell Oil Co., Shell Building Houston, Texas 77002 Mobil No. 28 (MIL-G-81322). Mobil Oil Corp., P.O. Box 3311 Beaumont, Texas 77704
	Single element fuel pump drive shaft	Sundstrand 688272-1 or 688272-2 (recommended) Sundstrand Corp. 4751 Harrison Ave. Rockford, Illinois 61108
		Plastilube No. 3 Warren Refining Division Parr Inc. 5151 Denison Ave. Cleveland, Ohio 44102
Petrolatum Sealant	Metallic seal and bearing installation Assembly—oil bellows seal	Vaseline. No. 1372W. Permatex Co. Inc. Box 1350 Flager Court Building West Palm Beach, Florida 33402
Antiseize	Antiseize compound — consisting of (by weight): 40% molybdenum disulfide (Molykote Type Z, or equiv.) 60% MIL-L-23699 oil	Molykote Type Z Dow Corning Corp. South Sagihaw Road Midland, Michigan 48641
Methylethylketone Carbon removal compound	General cleaning Clean aluminum-coated steel parts	Gunk Hydroseal Decarbonizer (MIL-C-25107). Gunk Laboratories Inc. 630 North Harlem Ave. Oak Park, Illinois 60302
Cresol base cleaning compound	Clean steel parts	Formula No. 3097 (MIL-C-5546). Turco Products Inc., 2400 South Main St. Wilmington, California 90746



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TABLE III-1 (cont)

<i>Material</i>	<i>Usage</i>	<i>Acceptable Source</i>
Aircraft skin cleaner	Clean compressor air flow path, fuel nozzle, and burner drain valve	No. 512M or 715N Safety-Solv (MIL-C-22543 or MIL-C-43616). Brulin and Co. Inc., 2920 Martindale Ave. Indianapolis, Indiana 46205  20-20 Plus (MIL-C-43616) B&B Chemical Co., Inc. P.O. Box 796 Miami, Florida 33166  B & B 3100 B & B Chemical Co. Inc. P.O. Box 796 Miami, Florida 33166
Perchloroethylene or methylene chloride	Cleaning	Commercial
Sodium hydroxide and phosphoric acid	Cleaning P <sub>c</sub> filter	
Sodium dichromate and sulphuric acid	Cleaning P <sub>c</sub> filter	
Mineral spirits	General cleaning	
Calibration fluid	Cleaning fuel nozzle tips	Stoddard solvent, refined kerosene (MIL-F-7024, type II) 300-400 boiling range.
Carbon solvent	Cleaning fuel nozzle	No. 26. Cities Service Oil Co., P.O. Box 300 Tulsa, Oklahoma 74102
Rust preventive compound	Coat steel parts after cleaning	Anti-Corrode 204 (MIL-C-6529, type 1). Cities Service Oil Co., P.O. Box 300 Tulsa, Oklahoma 74102
Preservation oil	Fuel system preservation	No. 31100 (MIL-L-6081, grade 1010). Atlantic Richfield Co., 260 South Broad St. Philadelphia, Pennsylvania 19101 (or) Gulflite 6 (MIL-L-7870A). Gulf Oil Corp., 439 7th Ave. Pittsburgh, Pennsylvania 15230
Chemical film	Treat cleaned anodized aluminum-alloy parts	Chem-Rite A22 (MIL-C-5541). M and T Chemicals Inc., Church St. Matawan, New Jersey 07747
Moisture absorbing rust preventative	Compressor preservation	No. 606. Rust Lick Incorporated 755 Boylston Street Boston, Massachusetts 02116 (or) Rocket WD 40 (MIL-C-23411). WD-40 Co. San Diego, California



TABLE III-1 (cont)

<i>Material</i>	<i>Usage</i>	<i>Acceptable Source</i>
Moisture absorbing rust preventive (cont)		WD-40 Dr. Oskar Trost 415 Krefeld/Linn Hafenstrasse 60, West Germany WD-40 Hawker de Havilland Australia Pty. Ltd. Commercial Products Division P.O. Box 78, Lidcombe N.S.W. 2141 Australia Pengard Penetone Co. Ltd. Bassington Industrial Estate Cramlington Norththunderland United Kingdom Ardrox 3961 Ardrox Limited Commerce Road Brentford, Middlesex, England (or) Ardrox Australia Pty. Ltd. Lidscombe N.S.W. Australia CRC 3-36 CRC Chemicals Division C. J. Webb Inc. Limekiln Pike Dresher, Pennsylvania 19025
Heat resistant paint	Galvanic corrosion protection	Actithane WC 100 Saran Protective Coatings Co. 830 Drayton Ferndale, Michigan 48220
Lacquer reducer	Galvanic corrosion protection; used with Actithane WC 100.	Actithane H 251 Saran Protective Coatings Co. 830 Drayton Ferndale, Michigan 48220
Engine gray enamel	Gearbox touch-up	No. S 1435 (MIL-E-7729, color 513). O'Brien Corp. 2001 West Washington Ave. South Bend, Indiana 46621
Corrosion resistant aluminum paint	Compressor case and scroll touch-up	Sermetel 196. Teleflex, Inc. P.O. Box 218 North Wales, Pennsylvania 19454
Weld rod	First-stage turbine nozzle	Hastelloy X (AMS 5798) or alternate L-605 (AMS 5796).

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TABLE III-1 (cont)

<i>Material</i>	<i>Usage</i>	<i>Acceptable Source</i>
Weld rod	Combustion liner and exhaust collector support	AISI 349, 29-9 W Mo (AMS 5784) (MIL-R-5031, class 6).
Weld rod	Exhaust Collector Support	Hastelloy W (AMS 5786) (MIL-R-5031, class 12).
■ Marking pencils	Marking hot section parts	See Table III-1A.
Moisture proof barrier material	Engine packaging	Flexkin 100P (MIL-B-131). Acme Backing Corp., P.O. Box 360 Stamford, Connecticut 06904
Dehydrating agent 16-unit bags	Storage and shipment	CS-16 (MIL-D-3464). Filtrol Corp., 3250 East Washington Los Angeles, California 90023
Pressure sensitive masking tape— 1-or 2- in. width	Storage and shipment	No. 260 Scotch Brand. Minnesota Mining and Mfg. Co. 3M Center St. Paul, Minnesota 55101
Black stencil ink	Storage and shipment	K-1 (TF-I-559). Marsh Stencil Machine Co. 707 East B St. Belleville, Illinois 62222
High temperature lubricant	P <sub>c</sub> filter assembly	Never-Seez Nickel Special Never-Seez Compound Corp. 2910 South 18th St. Broadview, Illinois 60153  Bearing Supply and Service 448-472 Notre Dame Ave. Winnipeg 2, Canada  R. A. Rodriguez (U. K.) Ltd. Station House-Darkes Lane Potters Bar Herts, England  Consolidated Brg. Co. Pty. Ltd. 238 Victoria Rd. Drummoynes, N. S. W. Australia  Kyokuto Boeki Kaisha Ltd. 7th Floor, New Otemachi Bldg. 2-1, 2-Chome, Otemachi Chiyoda-Ku, Tokyo, 100-91 Japan  S. A. Brasileira De Rolamentos E. Mancais BRM Av. Senador Queiroa, 605 Conj. 1609 Sao Paulo, Brazil  Tekind Via F. Melzi D'Eril, 3 20154 Milano, Italy



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TABLE III-1 (cont)

<i>Material</i>	<i>Usage</i>	<i>Acceptable Source</i>
Sealer	Compressor mounting insert installation	Devcon F (aluminum). Devcon Corp. 59 Endicott St. Danvers, Massachusetts 01923
		Resiweld FE 186 H. B. Fuller Company 2400 Kasota Ave. St Paul, Minnesota 55102
		Metal Set A-4. Smooth-on Inc. 1000 Valley Road Gillette, New Jersey 07933
	Epon 934 Hysol Div. Dexter Corp. 2850 Willow Pass Road Pittsburgh, Calif. 94565	
	Compressor case splitline	RTV 731 Dow Corning Corp. South Saginaw Road Midland, Michigan 48640
	Assembly-gearbox splitline	Scot Clad 776 Scotch Clad Coatings Minnesota Mining and Mfg. Co. 3-M Centre St Paul, Minnesota
Liquid leak detector	Checking for pneumatic leaks	SNOOP (meets Mil Spec MIL-L-25567C, type 1 oxygen systems) Indiana Valve & Fitting Inc P.O. Box 24267 Indianapolis, Ind. 46224
Methyl alcohol (Fed Spec O-M 232d, grade A; Allison EMS-125)	Cold weather compressor water rinse	Commercial Solvents Corp., 245 Park Ave. New York, N.Y. 10017
		Union Carbide Corp. Chemicals and Plastics 270 Park Ave. New York, N.Y. 10017
Desiccant	Shipping package humidity control	No. 88 Absorbant Protective Dehydrating Agent (MIL-D-3464) Delta Packaging Products 4108 North Nashville Avenue Chicago, Illinois 60634



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TABLE III-1A

**Acceptable Marking Pens and Pencils**

**NOTE:** The following pencils, fine tip and wide markers, ball paint markers, and paint stiks are approved for marking iron, nickel and cobalt base alloys which are exposed to temperatures above 800°F (427°C) either by heat treatment or engine operation. Markings on these alloys do not have to be removed from the parts prior to heating above 800°F (427°C).

These pencils, markers and paint sticks are also approved for marking titanium alloys providing the markings are removed prior to exposure of the parts to temperatures above 500°F (260°C) by heat treatment or engine operation.

<u>Manufacturer</u>	<u>Trade Name</u>	<u>Number</u>	<u>Color</u>
<b><u>Pencils</u></b>			
Venus <sup>(1)</sup>	Unique	1237	Carmine Red
Berol Corp. <sup>(2)</sup>	Eagle Verithin	745	Carmine Red
A.W. Faber <sup>(3)</sup>	The Winner	2383	Dark Green
Berol Corp. <sup>(2)</sup>	Eagle Verithin	751	True Green
A.W. Faber <sup>(3)</sup>	The Winner	2388	White
Venus <sup>(1)</sup>	Unique	1215	White
Berol Corp. <sup>(2)</sup>	Eagle Verithin	734	White
Venus <sup>(1)</sup>	Unique	1206	Blue
Koh-I-Noor <sup>(4)</sup>	Flexicolor	X1800X25	Blue
Berol Corp. <sup>(2)</sup>	Eagle Verithin	758	True Blue
Berol Corp. <sup>(2)</sup>	Eagle Verithin	737	Orange
A.W. Faber <sup>(3)</sup>	The Winner	2462	Silver
Berol Corp. <sup>(2)</sup>	Eagle Verithin	753	Silver
Eberhard Faber <sup>(5)</sup>	Colorbrite	2101	Silver
<b><u>Fine Tip Markers</u></b>			
Carters <sup>(6)</sup>	Marks-A-Lot	—	Yellow
Berol Corp. <sup>(2)</sup>	Flash 30	—	Red
—	Lindy	—	Green
Berol Corp. <sup>(2)</sup>	Flash 30	—	Blue
—	Lindy	—	Blue
Berol Corp. <sup>(2)</sup>	Flash 32	—	Blue
<b><u>Wide Tip Markers</u></b>			
Blaisdell <sup>(2)</sup>	Liquid Tip	1100	Black
Berol Corp. <sup>(2)</sup>	Eagle Marker	8835	Black
Blaisdell <sup>(2)</sup>	Liquid Tip	1100	Red
Berol Corp. <sup>(2)</sup>	Eagle Marker	8824	Red
Berol Corp. <sup>(2)</sup>	Eagle Marker	8802	Blue
Berol Corp. <sup>(2)</sup>	Eagle Marker	8816	Yellow



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TABLE III-1A (cont)

<u>Manufacturer</u>	<u>Trade Name</u>	<u>Number</u>	<u>Color</u>
<b>Ball Paint Markers</b>			
Markall <sup>(7)</sup>	—	—	Blue
Markall <sup>(7)</sup>	—	—	Yellow
<b>Paint Stiks</b>			
Markal Company <sup>(7)</sup>	Paintstik Type B		Yellow
Markal Company <sup>(7)</sup>	Paintstik Type B		White
Markal Company <sup>(7)</sup>	Paintstik Type B		Green
Markal Company <sup>(7)</sup>	Paintstik Type B		Brown
Markal Company <sup>(7)</sup>	Paintstik Type B		Orange
Markal Company <sup>(7)</sup>	Paintstik Type B		Purple
American ArtClay Co. Glass Cellophane No. 2346 <sup>(8)</sup>			Blue

**NOTE:** Dri-Marquette Black Ink, a product of the Irwin-Hodson Co.,<sup>(9)</sup> is approved for marking on iron, nickel and cobalt base alloy parts. The markings do not have to be removed prior to exposure to temperature above 800°F (427°C).

Dri-Marquette Black Ink may be used on titanium alloys but must be removed prior to exposure to temperatures above 500°F (260°C).

LNC-3 Nuclear Grade Electrolyte, a product of The Lectroetch Company,<sup>(10)</sup> is approved for electrolytic etching on iron, nickel, cobalt, titanium, aluminum and magnesium alloys. This process is for permanent marking of identification on parts.

Pyromarker, a product of Ball Point Metal Marker, Tempil Division, Big Three Industries, Inc.<sup>(11)</sup> is approved for marking on iron, nickel and cobalt base alloys and on titanium alloys. Markings on these alloys do not have to be removed prior to exposure to temperatures above 500°F (260°C).

**Manufacturer Addresses**

- (1) Venus-Esterbrook Corp.; Lewisburg, Tenn. 37091
- (2) Berol Corp.; P.O. Box 1000, Danbury, Conn. 06810
- (3) Farber-Castell Corp.; P.O. Box 7099, Newark, New Jersey 07107
- (4) Koh I-Noor Rapidograph Inc.; 100 North Street, Bloomsbury, New Jersey 08804
- (5) Eberhard Faber Inc.; Crestwood Industrial Park, Wilkes-Barre, Pennsylvania 18703
- (6) Carters Ink Co.; 275-T Wyman St., Waltham, Mass. 02154
- (7) Markall Co.; 270 North Washtenaw Ave., Chicago, Ill. 60612
- (8) American Art Clay Co. Inc.; 4717 West 16th St., Indianapolis, Ind. 46224
- (9) Irwin-Hodson Co.; Ninth and S.E. Woodward, Portland, Oregon 97202
- (10) The Lectroetch Co.; 14925 Elderwood Ave., Cleveland, Ohio 44112
- (11) Tempil Division Big Three Industries Inc.; 2901 Hamilton Blvd. South Plainfield, N. J. 07080



TABLE III-2

Minimum Prevailing Torque for Used Locknuts

<i>Fine Thread Series</i>		<i>Coarse Thread Series</i>	
<i>Nut Size</i>	<i>Min Torque (lb in.)</i>	<i>Nut Size</i>	<i>Min Torque (lb in.)</i>
8-36	0.7	8-32	0.7
10-32	1	10-24	1
1/4-28	2	1/4-20	2
5/16-24	3	5/16-18	3
3/8-24	5	3/8-16	5
7/16-20	8	7/16-14	8
1/2-20	10	1/2-13	10
9/16-18	13	9/16-12	14
5/8-18	18	5/8-11	20
3/4-16	27	3/4-10	27
7/8-14	40	7/8-9	40
1-12	55	1-8	51
1 1/8-12	73	1 1/8-8	68
1 1/4-12	94	1 1/4-8	88

TABLE III-3

General Torque Limits for Bolts, Nuts, and Screws

<i>Size</i>	<i>Type</i>	<i>Torque</i>
8-32	Screws, bolts and nuts	12-15 lb in.
8-36	Screws	17-20 lb in.
10-24	Screws	12-22 lb in.
10-24	Bolts and nuts	25-30 lb in.
10-32	Screws	22-26 lb in.
10-32	Bolts and nuts	35-40 lb in.
1/4-20	Bolts and nuts	60-65 lb in.
1/4-28	Flat, round, and fillister-head screws	50-58 lb in.
1/4-28	Bolts, nuts, and socket-head screws	70-85 lb in.
5/16-24	Bolts and nuts	120-150 lb in.
5/16-24	Self-locking nuts	140-170 lb in.
3/8-16	Bolts and nuts	205-245 lb in.
3/8-24	Bolts and nuts	240-280 lb in.
3/8-24	Self-locking nuts	265-300 lb in.
5/8-18	Bolts and nuts	90-100 lb ft.
	Palnuts	60° or one flat past finger tight



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3-16. When screws are installed with nuts, the torque for the screw shall apply. (See table III-3.) On nuts with a thread size larger than one inch, tighten nuts to maximum specified torque to seat parts. Loosen and retighten as specified.

3-17. When tightening or loosening coupling nuts, make sure the nipple does not turn on the seat of the mating fitting. Apply torque paint across the fitting threads after tightening fitting. Bottoming torque on bushing type parts that seat metal over a seal is the same as for fittings with like thread size. (See table III-4.)

**3-18. UNIVERSAL FITTINGS.** (See figure 3-2)

3-19. Use this procedure to install universal fittings with back-up rings.

a. Install the nut on the fitting and run it back until the counterbore of the nut aligns with the upper inner corner of the gasket groove.

b. Lubricate the seal and install it on the fitting.

c. Work the back-up ring into the counterbore of the nut.

d. Turn the nut down until the seal is pushed firmly against the lower threaded section of the fitting.

e. Install the fitting into the boss, making certain the nut turns with the fitting, until the seal touches the boss. Then tighten the fitting one and one-half turns more.

f. Put a wrench on the nut to prevent its turning, and position the fitting by turning it not more than one turn.

g. Hold the fitting in its position and tighten the nut against the boss.

3-20. Use this procedure to install universal fittings without back-up rings.

a. Run the nut on the fitting end back until the washer face is aligned with the upper inner corner of the gasket groove.

b. Lubricate the seal and place it in the groove.

c. Screw the fittings into the boss until the seal barely touches the boss.

d. Turn the fitting and nut together until the nut touches the boss.

e. Put a wrench on the nut to prevent its turning, and position the fitting by turning it in up to 270° or unscrewing it up to 90°.

f. Hold the fitting in its proper position and tighten the nut against the boss.

**TABLE III-4**

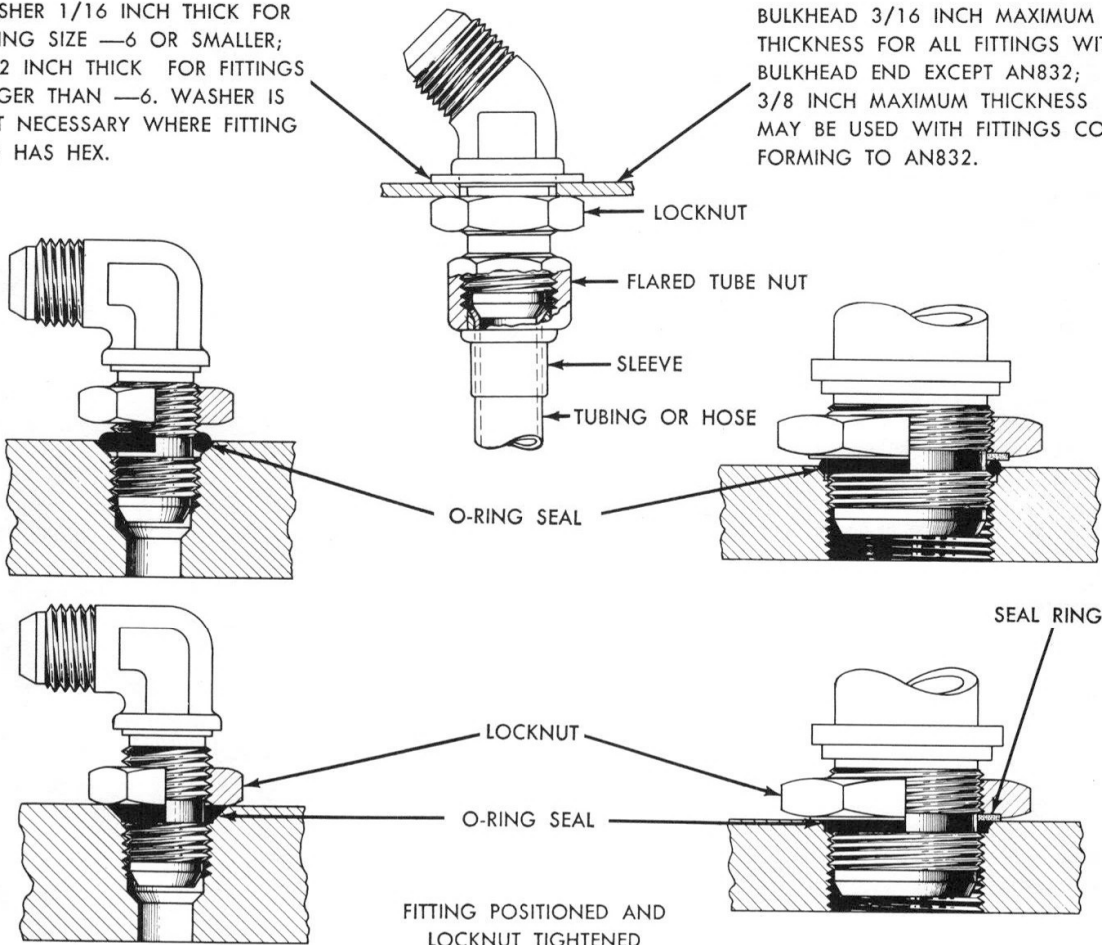
**Torque Limits for Fuel, Oil, Air, and Drain Lines**  
(Torque in pound inches)

<i>Application</i>	<i>Thread Size</i>				
	<i>5/16-24</i>	<i>3/8-24</i>	<i>7/16-20</i>	<i>1/2-20</i>	<i>9/16-18</i>
Steel coupling nuts on steel fittings	35-40	65-100	80-120	150-200	200-250
Steel or aluminum coupling nuts on aluminum fittings	15-25	25-40	40-65	60-80	80-120
Aluminum or steel universal fitting locknuts (plain)	18-25	50-75	55-80	75-110	100-150
Aluminum or steel unions	18-25	50-75	55-80		100-150
Plugs and bleeders	10-16	30-40	40-65	60-80	80-120
Pipe plugs	Tighten enough to seal				
Aluminum clamps			40-65		80-120
Aluminum and steel universal fitting bolts			150-200	175-225	200-250
Hose clamps	Initial installation		15-20		Retightening 10-15



WASHER 1/16 INCH THICK FOR FITTING SIZE —6 OR SMALLER; 3/32 INCH THICK FOR FITTINGS LARGER THAN —6. WASHER IS NOT NECESSARY WHERE FITTING END HAS HEX.

BULKHEAD 3/16 INCH MAXIMUM THICKNESS FOR ALL FITTINGS WITH BULKHEAD END EXCEPT AN832; 3/8 INCH MAXIMUM THICKNESS MAY BE USED WITH FITTINGS CONFORMING TO AN832.



FITTING POSITIONED AND LOCKNUT TIGHTENED

Figure 3-2. Universal Fittings

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**3-21. RIGID TUBE INSTALLATION.**

3-21A. When a component to which rigid tube assemblies are attached is replaced, remove all interfering tube assemblies to permit easy removal and reinstallation of the component. This precaution will prevent subsequent damage to the tube assemblies.

**3-22. FLARED TUBES.**

3-23. Tube assemblies must fit and be aligned with the mating flare tube fittings to the degree that at both ends of the assembly the flares shall uniformly seat in a free state on the cones of the mating fittings. The fit shall be without distortion or stretching of the tube assembly and to the degree that the nuts can be fully engaged up to the final one-half turn with light finger pressure. In the event a tube does not align with the mating fittings, reposition

the mating fittings to the degree that proper alignment may be attained. Final tightening of these fittings must be accomplished before the tube assembly is connected.

3-24. If proper alignment cannot be attained by repositioning mating flare tube fittings, bend the tube sufficiently to provide alignment in the free state as specified. Accomplish all bending with the tube removed from the engine. Adjustment of the fit may be accomplished by bending by hand at principal bends. In the event the tube cannot be bent by hand, the tube must be clamped in a fixture or device which will not scratch, indent, crimp, or mark the surface of the tube during the bending operation. The flattening effect of the cross section of the tube as a result of the reforming operation must not exceed 15 percent of the tube OD.



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3-25. When proper free state alignment is attained complete the tubing installation by simultaneously securing the coupling nuts and tightening them to proper torque.

**3-26. FLANGED TUBES.**

3-26A. The alignment of tube fittings with mating sealing surfaces and the securing of tube clips must conform to the following:

a. Nut and Nipple Joints. With one end hand tightened, it must be possible to locate the nipple at the free end in its conical seating, by flexing the tube by hand, without effecting a permanent set to the assembly. The alignment of the joint must be such that the nut readily engages with its mating thread.

b. Setscrew Retained Flanged Adapters. The clearance and parallelism between flange and mating surface, with the opposite end secured, must be such that the total flange area contact can be achieved by flexing the tube by hand, without effecting a permanent set to the assembly. Flange clearance holes must line up with tappings such that bolts can be fitted without subjecting the tube to a torsional load.

c. Clipping Points. Locate clips to securing points such that the setscrews can be fitted by flexing the tube by hand, without effecting a permanent set to the assembly. Tubes which fail to meet this requirement may be removed from the engine and reformed as follows:

(1) Tubes must be clamped in a fixture which will not scratch, indent, crimp or mark the surface of the tube during the bending operation.

(2) Retention of the tube during bending should be made in a manner which does not permit bending or torsional loads across welded or brazed areas.

(3) Tubes which can be corrected for fit only by submitting welded areas to bending or torsional loads, must be reinspected by X-ray or Zyglo for any evidence of weld or braze fracture prior to reinstallation on the engine.

(4) Reformed tubes must meet the requirements of steps a and b.

d. When removal of the tube from the engine would result in excessive lost time due to the need for tear-down and rebuild, the tube may be reformed attached to the engine if the following precautions are followed:

(1) Bending and torsional loads must not be applied across welded or brazed areas.

(2) The tube attachment points are to be loosened after bending (attachment points which are inaccessible due to the state of assembly are excluded).

(3) Reformed tubes must meet the requirements of steps a and b.

**3-27. CLEANING.**

**3-28. General.** Use care in separating metals for cleaning. Cleaners for steel will damage nonferrous parts.

a. Mineral spirits is the cleaning solvent recommended for nonferrous parts. Do not use rust preventives on magnesium and aluminum parts.

----- **WARNING** -----  
*Mineral spirits is toxic. Provide adequate ventilation for personnel using it.*  
-----

b. Clean aluminum-coated steel parts with carbon removal compound (Gunk Chicago Co., Gunk Hydroseal Decarbonizer, or equivalent). Rinse the parts with water and dry with an air blast.

c. Clean steel parts with cresol base cleaning compound (Turco Products Inc., Formula 3097, or equivalent). Rinse the parts thoroughly with hot water. Coat parts with a compound made of one part of rust preventive (Cities Service Anti-Corrode 204, or equivalent) and three parts oil (Atlantic Refining Co. 31100, or equivalent).

----- **NOTE** -----  
*Do not allow bearings to spin during drying after the cleaning operation. Lubricate the cleaned bearings lightly with engine oil and wrap to keep clean while waiting for engine assembly.*  
-----

----- **CAUTION** -----  
*Engine thermocouples should never be immersed or sprayed with cleaning solvents. Liquid cleaning solvents will penetrate the porous magnesium oxide insulation. Engine heat will vaporize the solvents leaving a residue containing carbon which causes a low resistance to ground.*  
-----



**Detroit Diesel Allison**

Division of General Motors Corporation

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**3-28A. Compressor.**

3-28B. The cleaning and preservation practices which are necessary for proper maintenance of the compressor are as follows:

a. Water rinse. Accomplish on a daily basis in salt water areas using the best water available. Useable water can be obtained from the discharge of an air conditioner or from a cistern. It is not necessary to disconnect any tubing during the water rinse; however, the bleed valve

must be blocked in the closed position. (Refer to Compressor Salt Water Contamination Removal, para 3-30.)

b. Cleaning. Accomplish when the compressor becomes dirty using aircraft skin cleaner. Cleaning is normally required after 200-300 hr of operation in smoggy areas. Tubing must be removed and the bleed valve must be blocked closed during the cleaning. (Refer to Compressor Cleaning, para 3-29.)

c. Preservation. Accomplish when the engine will be idle for extended periods of time using moisture absorbing rust preventive. (Refer to Compressor Preservation, para 3-45.)



**3-29. Compressor Cleaning.** Clean the compressor to regain lost performance due to buildup of dirt. Do not spray cleaning solution into a hot engine. The engine temperature should be satisfactory for cleaning when the bare hand can be placed on the outer combustion case without discomfort. Clean as follows:

a. The solution for cleaning the compressor blading consists of one part aircraft skin cleaner (Burlin No. 512M or 715N Safety-Solv, or equivalent) to six parts of clean water (distilled if available).

----- **CAUTION** -----

*Once the compressor blade cleaning procedure has been started it must be carried through to completion without delay.*



b. Disconnect the control system P<sub>c</sub> air tube at the compressor scroll pressure probe elbow. Cap the elbow and the air tube using the compressor protector cleaning kit 6798861.

c. Retain the anti-icing valve in the closed position. Disconnect the bleed valve pressure sensing tube at the compressor scroll pressure probe elbow. Cap the pressure probe and sensing tube and block the bleed valve in the closed position using the 0.60 in. (15.2 mm) dimension of the wedge in 6886204 compressor protector cleaning kit. (See figure 3-2A.)

----- **NOTE** -----

*Use of a steam powered aspirator and hot water is desirable, if available.*



d. Spray at least one quart of the cleaning solution into the compressor inlet while motoring the engine with the starter without ignition. Inject solution with an aspirator or sprayer equipped with a quick opening valve. Start injection three seconds prior to starter engagement and disengage starter at 10% N<sub>1</sub> rpm. Inject one quart in 9 to 11 seconds to maintain speed below 10% for duration of injection. Repeat injection cycle as necessary to clean compressor.

e. After injection of cleaning solution, spray steam or clean water (distilled preferred) into the compressor inlet. Start injection three seconds prior to starter engagement, injecting one pint to one quart in approximately 5 to 10 seconds, and again disengaging starter before speed accelerates above 10% N<sub>1</sub> rpm.

----- **CAUTION** -----

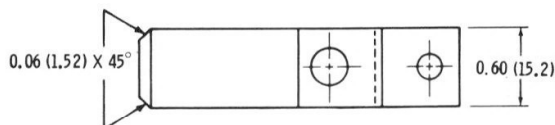
*Do not exceed 10% N<sub>1</sub> rpm motoring speed during cleaning or rinsing cycles. Do not inject a solid stream of fluid into the compressor.*



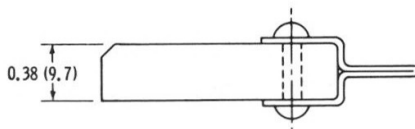
f. If power is not restored after the compressor has been cleaned with aircraft skin cleaner, reclean as follows:

(1) Remove one case half and clean the blades and vanes with a small brush (toothbrush) and a mild dishwashing detergent (Lux or equivalent).

(2) Reinstall the cleaned case half. Remove the second (dirty) case half. Clean blades and vanes and replace case half in the same manner as used with the first case half.



NOTE: DIMENSIONS ARE IN INCHES (MILLIMETERS)



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Figure 3-2A. Bleed Valve Wedges



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f. Clean the bleed valve. (Refer to Bleed Valve Cleaning, para 3-138.)

g. Remove the compressor cleaning kit 6798861 (block and caps). Reconnect the two P<sub>c</sub> air tubes.

h. Start and operate the engine for a minimum of five minutes. Operate the engine anti-ice system to purge the solution from the compressor inlet housing. Also, operate any aircraft system which utilizes compressor bleed air. Complete the engine drying run as soon as possible after cleaning and rinse.

**3-30. Compressor Salt Water Contamination Removal.**

Engines subjected to salt water contamination shall undergo water rinsing after shutdown following the last flight of the day. Perform the rinse operation as soon as practical after flight, but not before the engine has cooled to near ambient temperature.

a. Precautions to be observed during the spray rinse.

(1) Do not perform the rinse procedure while the engine is operating at idle speed.

(2) N<sub>1</sub> speed must not exceed 10% rpm during water spray injection.

(3) Use the cleanest water available.

(4) Do not spray water into a hot engine. The engine temperature should be satisfactory for water rinse when the bare hand can be placed on the outer combustion case without discomfort.

(5) Avoid conditions which would allow the rinse water to freeze.

----- NOTE -----

*Methyl alcohol may be added to the water to prevent freezing during water rinse in below freezing weather. Mix one part methyl alcohol to one part water. This mixture prevents freezing down to -40°F. The methyl alcohol shall contain methanol in concentrations not less than 99.85% by volume. (See table III-1.)*

----- CAUTION -----

*Be sure the ignition circuit breaker is pulled to prevent ignition during the wash cycle when the methyl alcohol mix is used.*

(6) Do not inject a solid stream of water into the engine. The nozzle must provide a diffused spray pattern.

(7) Hold the nozzle so that the spray is centered around the bullet nose of the inlet to insure that all of the spray is injected into the engine. Spray a minimum of one quart into the compressor; there is no maximum limit.

b. Materials and equipment.

(1) Clean water must be used. Demineralized, distilled, or rain water is preferred. City drinking water, well water, lake, or river water may be used if free of contaminants such as mud, sulphur, sand, salt, etc.

(2) The source of pressure most readily available is a water supply system (which usually has 40-70 psi pressure). Portable equipment using air pressure up to 100 psi is also satisfactory for use.

(3) The spray nozzle shall provide a diffused spray of water at a flow rate of one quart in nine to eleven seconds at the pressure conditions used during compressor rinse. The nozzle should be sized to provide the proper flow rate at the average pressure maintained during each rinse cycle.

----- NOTE -----

*Test for proper water flow at the pressure to be used by placing the nozzle in a large container so that no water can splash out. Time the flow for 10 seconds and measure the quantity collected. Proper nozzle size for the pressure used should accumulate 1 to 1-1/8 quarts. Adjust nozzle size as necessary to meet the specified flow limits.*

(4) A quick opening valve shall be installed in the supply tube as close to the nozzle as practical.

(5) 6886204 Compressor Cleaning Protector Kit (bleed valve wedge).

c. Spray rinse procedure.

(1) Pull the engine ignition circuit breaker.

(2) Block the bleed valve in the closed position using the wedge in 6886204 compressor cleaning protector kit. (See figure 3-2A.) It is not necessary to disconnect any lines.

(3) Spray water into the compressor inlet for 10 seconds while the engine is being motored with the starter. Start the water injection three seconds prior to starter engagement. The three second delay will reduce the tendency of the engine to accelerate above 10% rpm. The spray must flow the water as close to the bullet nose of the compressor inlet as possible to ensure that all of the spray is injected into the engine. Do not flood the engine prior to starter engagement.



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----- NOTE -----

*Observe engine speed during the 10 second rinsing operation. The engine rpm will generally stagnate at or just below 10%; but, when using a fully charged battery or an A.P.U., the rpm may tend to exceed 10%.*

----- CAUTION -----

*To prevent possible blade damage and to assure adequate rinse at the base of the blades N<sub>1</sub> must not exceed 10% rpm. If N<sub>1</sub> rpm reaches 10%, release the starter and continue the water spray. Permit N<sub>1</sub> rpm to reduce to approximately 5% and then re-energize the starter to obtain a full ten seconds of engine rotation while water is sprayed into the compressor.*

(4) Continue injection of water spray during coast down until N<sub>1</sub> stops; this improves the rinse of the base of the blades. Do not continue spray after engine stops.

(5) While engine drains, remove the bleed valve wedge.

(6) Within 15 minutes of the water rinse, operate the engine at idle for five minutes to purge and evaporate all residual water as soon as possible (actuate anti-icing system for one minute.

----- NOTE -----

*If exposure to excessive salt or other corrosive media has occurred, a repeat of the rinse procedure may be necessary. In cases where the engine has not been receiving regular daily water rinsing, double rinse may be required to prevent corrosive attack of metals in the engine.*

**3-31. CORROSION TREATMENT AND SURFACE FINISH REPAIR.**

3-32. Make repair of corrosion and surface finish damage as follows.

3-33. Touch up damaged paint on magnesium alloy parts with engine gray enamel (AMS 2510).

3-34. On aluminum-alloy parts which were originally painted without anodizing, touch up reworked areas with zinc-chromate primer (AMS 3110), then repaint.

3-35. On aluminum-alloy parts which were originally anodized, clean damaged areas with mineral spirits and rinse the part with water. Treat the damaged area with chemical film. (Chem-Rite A22 or equivalent manufactured by Hanson-VanWinkle-Munning Co., Matawan, N.J.). As an alternate use chromic acid. If the coating is soft and powdery, the solution is too strong or the reaction time is too long; dilute the solution with water. If little or no visible coating forms, increase either the solution concentration or the reaction time.

3-36. Use the following procedure on aluminum-coated steel parts. Apply corrosion-preventive paint only forward of the turbine unit; the surface heat of the engine aft of the gearbox will destroy the paint.

a. Clean the damaged surface with perchlorethylene and let dry five to ten minutes; clean all welds with a stainless-steel brush.

b. Mask all vent holes.

c. Paint all surfaces with heat-resisting aluminum paint (Lankote P/N 620 or equivalent, made by J. Landau Co. N. Y.). Apply and let dry for one hour.

----- NOTE -----

*Do not paint compressor case vanes.*

3-37. Use the following corrosion treatment procedure for repair of the compressor case and scroll finish.

a. Clean the area to be touched up with trichloroethylene, acetone, or alcohol and allow to air dry for 5 - 10 minutes.

b. Sand an area slightly larger than the damaged area; feather out edges.

c. Reclean area and dry with filtered, compressed air.

d. Paint surface with Sermetel 196 paint, Teleflex, Inc., P.O. Box 218, North Wales, Pa. Air dry for at least one hour.

e. Apply a second coat and air dry for 72 hours.

3-38. **Galvanic Corrosion Protection.** Specific engine areas shall be protected against galvanic corrosion by a protective paint seal covering joints between dissimilar materials. The protective paint must be applied to the specified area after the units are assembled when the area is accessible and not affected by subsequent disassembly or loosening of affected parts. If it becomes necessary to disturb an original paint seal, that area shall be resealed with paint.





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3-39. Specific areas requiring protective paint (areas joining dissimilar metals) are as follows.

- a. Rear diffuser-to-gearbox mounting pads.

----- **CAUTION** -----

*Keep paint off the compressor mounting insert face.*

- b. All fittings and steel bushings except plastic shipping plugs.
  - c. At steel accessory cover plates shipped on pads. Paint attachment fasteners and interface splitline after cover plate installation (splitlines for plates with gaskets excluded).
  - d. Splitline washers and/or studs and mounting bolts attaching engine mounting brackets.
  - e. Around magnetic drain plugs and their inserts after plug installation.
  - f. Torquemeter support shaft nuts at interface splitlines after nut installation.
  - g. Turbine assembly mounting pads on gearbox cover.
  - h. Gearbox cover mounting face provided for the turbine.
- Paint the depressed (fireshield) area bounded by the four adjacent turbine mounting bosses.

3-40. Use the following paint, or equivalent, for galvanic corrosion protection:

- a. Paint. Nubelon S No. 16473 Gray (Glidden Company, Cleveland, Ohio).
- b. Thinner. Special Lacquer Reducer No. 9012 (Glidden Company, Cleveland, Ohio.)

----- **NOTE** -----

*Mix two parts paint by volume to one part thinner by volume.*

3-41. Clean, paint, and cure the area requiring protection as follows:

- a. Immediately before application of paint, thoroughly clean the area using acetone, methylethylketone, or toluene. Do not handle the area with bare hands or soiled gloves during or after cleaning.
- b. Apply paint by spray or brush. Air dry for 20 minutes. Flow a continuous film of paint at the interface area of all dissimilar metals so that the area is completely sealed against moisture. This applies to all areas not previously protected and/or to areas on which a previously applied film should need repair.

**3-42. PRESERVATION AND DEPRESERVATION.**

3-43. Areas of the engine requiring preservation are the fuel system and the compressor.

**3-43A. Installed Engine Preservation.** Preserve the engine, installed in an aircraft, as warranted by local corrosive conditions encountered.

- a. Be sure the oil tank is full; this will ensure oil flow to the bearings.
- b. Preserve the fuel system in accordance with Fuel System Preservation, para 3-44, if the shutdown period will exceed 45 days.
- c. Preserve the compressor and engine gas path in accordance with Compressor Preservation, para 3-45, if warranted by local corrosive conditions.
- d. Install covers on the compressor inlet and the exhaust collector stacks.
- e. The aircraft should be stored indoors where practicable.

**3-44. Fuel System Preservation.** If the engine will be stored for over 45 days the fuel system shall be preserved as follows:

- a. For engines not installed in airframe:
  - (1) Remove the hose from the fuel nozzle; place the open hose end in a bucket.
  - (2) Loosen the clamp supporting the two tubes (P<sub>o</sub> and P<sub>1</sub>) between the fuel control and the fuel pump. Remove the control bypass (P<sub>o</sub>) tube and plug the P<sub>o</sub> opening in the fuel control.
  - (3) Supply filtered (10 micron) MIL-L-6081 grade 1010 oil (Atlantic Refining Co. No. 31100 or equivalent) or alternate MIL-L-7870A oil (Gulf Oil Corp. Gulflite 6 or equivalent) at 50 psig to the fuel pump inlet of a static engine.
  - (4) Move the fuel control cutoff lever to the open position.
  - (5) When oil is observed flowing into the container, remove the oil supply to the pump and move the fuel control cutoff lever to the closed position.
  - (6) Permit the excess oil to drain from the fuel system before removing the plug and reassembling the fuel system components. Tighten hose coupling to 80-120 lb in. (9.04-13.56 N-m), tighten P<sub>o</sub> tube coupling nuts to 150-200 lb in. (16.95-22.60 N-m); tighten clamp nut to 35-40 lb in. (3.95-4.52 N-m).
- b. For operable engines installed in airframe:
  - (1) Remove the hose from the fuel nozzle; place the open hose end in a bucket.
  - (2) Supply filtered (10 micron) MIL-L-6081 grade 1010 oil (Atlantic Refining Co. No. 31100 or equivalent) or alternate MIL-L-7870A oil (Gulf Oil Corp. Gulflite 6 or equivalent) to the fuel pump inlet at 50 psig (345 kPa).



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(3) Move the condition lever to the maximum position and motor the engine with the starter (without ignition). When oil is observed flowing into the bucket, move the condition lever to FUEL OFF-FEATHER. Remove the oil supply to the pump inlet.

----- CAUTION -----

*Do not exceed starter limitations while motoring the engine.*

(4) Permit excess oil to drain from the fuel control then reinstall the fuel line. Tighten hose coupling to 80-120 lb in. (9.04-13.56 N-m).

c. Depreserve the engine fuel system by making a normal start.

----- NOTE -----

*In case of a false start or a start that is not completed in a total time of one minute, return the condition lever to FUEL OFF-FEATHER and motor the engine without ignition for 10 seconds.*

Allow the preservative to be drawn into the compressor for 15 to 20 seconds while spraying in a circular motion which covers the entire intake area.

(6) Remove the caps from the pressure probe elbows. Reconnect the control system and bleed control valve pressure sensing lines. Tighten coupling nuts to 80-120 lb in. (9.04-13.56 N-m).

(7) Remove the wedge which was used to block the bleed control valve in the closed position.

(8) Install the inlet and exhaust collector covers and keep the engine in a static condition after preservative application.

(9) Before starting the engine, remove the preservative and soft contaminants by water rinsing and drying the compressor in accordance with the procedure given in Compressor Salt Water Contamination Removal, para 3-30.

----- NOTE -----

*Operation of the engine prior to removal of compressor preservative may contribute to early contamination of the compressor blades with a resultant decrease in compressor efficiency. The recommended water rinse may be omitted only if available power is closely monitored and a compressor cleaning schedule is established.*

----- CAUTION -----

*This exception to the recommended water rinse is for preservation removal only and does not alter the requirement for daily water rinse following exposure to a salt water environment. (Refer to Compressor Salt Water Contamination Removal, para 3-25.)*

b. For operable engines installed in airframe:

----- NOTE -----

*To prevent the preservative from baking dry, be sure the compressor is cool to the touch (bare hand) before application is made.*

(1) Disconnect the fuel system pressure sensing ( $P_c$ ) line from the elbow at the diffuser scroll. Cap the line and the elbow.

(2) Disconnect the bleed control valve pressure sensing ( $P_c$ ) line from the elbow at the diffuser scroll. Cap the line and the elbow.

**3-45. Compressor Preservation.** Application of preservative to the compressor shall be made as warranted by local corrosive conditions encountered. In no case shall the shutdown period exceed 5 days without preserving the compressor.

a. For engines not installed in airframe:

(1) Disconnect the fuel system pressure sensing ( $P_c$ ) line from the elbow at the diffuser scroll. Cap the line and the elbow.

(2) Disconnect the bleed control valve pressure sensing ( $P_c$ ) line from the elbow at the diffuser scroll. Cap the line and the elbow.

(3) Block the bleed control valve in the closed position using compressor protector cleaning kit 6798861.

(4) Retain the anti-ice valve in the closed position.

(5) Turn the compressor rotor using a splined adapter and speed wrench at the spare pad on the rear of the gearbox (adjacent to governor). Spray the preservative (Rust-Lick No. 606, Rocket WD 40, or equivalent) into the compressor inlet while the rotor is being turned. Apply preservative using an aerosol pressure-type spray can. Hold the can 8 to 12 in. (20-30 cm) in front of the compressor.



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(3) Block the bleed control valve in the closed position using compressor protector cleaning kit 6798861.

(4) Retain the anti-ice valve in the closed position.

(5) Spray one-quarter pint of preservative into the engine while it is being motored with the starter and without ignition (ignition circuit breaker pulled). Use Rust-Lick No. 606, Rocket WD 40, or equivalent for the preservation. Use a sprayer with a quick opening valve and a nozzle sized to spray one-quarter pint of preservative in 1 to 3 seconds. Hold the can or sprayer 8 to 12 in. (20-30 cm) in front of the compressor. Allow the preservative to be drawn into the compressor while spraying in a circular motion which covers the entire intake area. As an alternate method of application use an aerosol pressure-type spray can. Spray preservative from the can for 15 to 20 seconds while the engine is being motored. Spray in a circular motion which covers the entire intake area.

----- CAUTION -----

*Do not exceed 10%  $N_1$  rpm motoring speed. Do not inject a solid stream of fluid into the compressor.*

-----

(6) Remove the caps from the pressure probe elbows. Reconnect the control system and bleed control valve pressure sensing lines. Tighten coupling nuts to 80-120 lb in. (9.04-13.56 N-m). On configurations have a  $P_c$  filter, hold the filter while tightening the coupling nut.

(7) Remove the wedge which was used to block the bleed control valve in the closed position.

(8) Install the inlet and exhaust collector covers and keep the engine in a static condition after spraying with preservative.

(9) Before starting the engine, remove the preservative and soft contaminants by water rinsing and drying the compressor in accordance with the procedure given in Compressor Salt Water Contamination Removal, para 3-30.

----- NOTE -----

*Operation of the engine prior to removal of compressor preservative may contribute to early contamination of the compressor blades with a resultant decrease in compressor efficiency. The recommended water rinse may be omitted only if available power is closely monitored and a compressor cleaning schedule is established.*

-----

----- CAUTION -----

*This exception to the recommended water rinse is for preservation removal only and does not alter the requirement for daily water rinse following exposure to a salt water environment. (Refer to Compressor Salt Water Contamination Removal, para 3-25.)*

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**3-46. LUBRICANTS.**

3-47. The following lubricants shall be used for assembly of the engine and at regular periodic lubrication of components.

**CAUTION**

Do not use silicone lubricants. Use only the lubricants recommended in the engine publications.

**NOTE**

Apply a light coat of lubricant by hand; wipe off any excess. Lubricate only the male threads of fuel and oil lines; wipe the lubricant from the lead threads to prevent it from entering the system. Do not mix synthetic lubricating oil with petroleum based products and do not lubricate air system component threads.

<i>Location</i>	<i>Lubricant</i>
General use such as installation of bearings, oil seals and O-rings	Engine oil

<i>Location</i>	<i>Lubricant</i>
Accessory gear splines and splines of engine components	Lubriplate 130A (or equivalent)
Gearbox seal lips and packing roller bearings for ease of assembly	Grease (Shell 6249 or equivalent)
Spanner nuts; external splitline nuts and bolts, and high temperature bolts	Antiseize compound: 40% by weight molybdenum disulfide (Molykote Type Z or equiv.) mixed with 60% by weight MIL-L-23699 oil.
P <sub>c</sub> filter threads during installation	Molybdenum disulfide (Electrofilm Lubri-Bond A Resin)
Fuel system preservation	MIL-L-6081 grade 1010 oil (Atlantic Refining Co. 31100 or equivalent) or MIL-L-7870A oil (Gulf Oil Corp. Gullite 6 or equivalent)

**3-48. TROUBLESHOOTING.**

3-49. Troubleshooting table III-5 has been prepared to assist in correction of malfunctions which could occur.

**TABLE III-5**

Troubleshooting			
<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
1	Engine fails to reach 15% cranking speed.	Inadequate torque at starter pad.	Check output of starter and battery.
		Binding N <sub>1</sub> .	Check inlet for foreign object damage. Rotate N <sub>1</sub> by hand and listen for abnormal noise.
2	Engine fails to light off.	Air in the gas producer fuel control and lines.	Try a second start.
		Preservation oil fouling the spark igniter.	Try a second start.
		Faulty circuit to ignition unit.	Listen for ignition operation. Observe for fuel vapor coming out of the exhaust. Check input power to ignition unit. Isolate and replace defective part.
		Faulty ignition exciter.	Listen for igniter operation. Observe for fuel vapor coming out of exhaust. Replace with known satisfactory unit. (Refer to Ignition Exciter, para 3-124.)



TABLE III-5 (Cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
2	Engine fails to light off. (cont)	Faulty spark igniter.	Listen for igniter operation. Observe for fuel vapor coming out of exhaust. Replace with known satisfactory unit. (Refer to Spark Igniter, para 3-123.)
		Insufficient fuel in tanks.	Fill tanks with correct fuel.
		Gas producer fuel control remains in cutoff.	Check linkage.
		Insufficient fuel pressure to fuel pump.	Turn on aircraft boost pump.
		Spark igniter firing intermittently.	Check input voltage to exciter. Check ignition exciter by replacing temporarily with a known satisfactory unit.
		Fuel nozzle valve stuck closed.	Replace fuel nozzle.
		Fuel pump inoperative. (Fuel vapor will not be observed leaving the exhaust.)	Check pump for sheared drives or internal damage; check for air leaks at inlet or fluid leaks at outlet.
		Water or other contaminant in fuel.	Check a sample of fuel from the bottom of the tank. If contaminated, disconnect the fuel line at the fuel nozzle, drain all fuel then flush the system with clean fuel.
		Fuel nozzle orifice clogged.	Check fuel pump filter, replace nozzle. (Refer to Power Control System, para 3-68.)
3	Engine lights off but will not accelerate to idle speed within the normal time period.	Improper pneumatic signal to gas producer fuel control.	Check air lines and fittings for looseness.
		Dirty P <sub>c</sub> filter.	Check for crack in air tubes or outer combustion case. Check for air seal leaks. Clean filter. (Refer to P <sub>c</sub> Filter, para 3-76.)
		Inadequate torque at starter pad.	Check condition of battery and starter to determine if sufficient N <sub>1</sub> cranking speed is attainable.
		Dirty compressor.	Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)
		Insufficient fuel supply to gas producer fuel control.	Check fuel system to ensure all valves are open and pumps are operative.
		Insufficient fuel pressure to fuel pump.	Turn on aircraft boost pump.



TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
3	Engine lights off but will not accelerate to idle speed within the normal time period.	Gas producer fuel control and/or power turbine governor bypass valve or relief valve stuck open. Fuel nozzle partially clogged with carbon. Fuel nozzle check valve stuck partially open. Gas producer fuel control incorrectly adjusted or calibration has shifted. Anti-icing valve open and cabin heat on. Foreign object damage or erosion to compressor Faulty power turbine governor.	Disconnect the fuel line at the fuel nozzle, flush system with clean fuel then replace control. Clean fuel nozzle. (Refer to Fuel Nozzle, para 3-73.) Replace fuel nozzle. Replace control. Close anti-icing valve and turn off cabin heat. Inspect compressor. (Refer to Blade and Vane Inspection, para 3-142.) Replace governor.
3A	Slow starts or low turbine temperature in the 35-50% N <sub>1</sub> speed range.	Control schedule has shifted lean (6899263, Bendix 2524654-9, or later fuel controls).	Turn the start/acceleration adjuster cw to increase turbine temperature and decrease start time. Make a one detent adjustment; then observe starting temperature. One detent changes temperature 30-40°C (86-104°F). Make an additional one detent adjustment if necessary. (Refer to Start/Acceleration Fuel Flow Adjustment, para 3-82A.)
3B	Low power and high TOT.	Contaminated bleed valve jet.	Clean bleed valve. (Refer to Bleed Valve Cleaning, para 3-138.)
3C	Hot starts or high turbine temperature.	Control schedule has shifted rich (6899263, Bendix 2524654-9, or later fuel controls).	Turn the start/acceleration adjuster ccw to decrease turbine temperature and to prevent hot starts. Make a one detent adjustment; then observe starting temperature. One detent changes temperature 30-40°C (86-104°F). Make an additional one detent adjustment if necessary. (Refer to Start/Acceleration Fuel Flow Adjustment, para 3-82A.)
4	Acceleration temperature too high during start.	Insufficient time allowed for draining after an unsuccessful starting attempt.  Reduced battery capacity. This can produce low cranking speed  High residual TOT in excess of 150°C.	Purge the engine by motoring with the condition lever in FUEL OFF-FEATHER and ignition switch in OFF for approximately 10 sec. before attempting a second start.  Recharge or replace battery.  Motor engine with starter leaving condition lever in FUEL OFF-FEATHER and ignition OFF.



TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
4	Acceleration temperature too high during start. (Cont'd.)	<p>Depreciated starter which is not capable of dry motoring gas producer (N<sub>1</sub>) above 15 percent.</p> <p>Condition lever in run position prior to and during starter engagement.</p> <p>Power lever positioned above ground idle during start.</p> <p>Dirty compressor.</p> <p>Fuel nozzle valve stuck full open.</p> <p>Excessive compressor air leaking.</p> <p>Bleed control valve stuck closed.</p> <p>Gas producer fuel control incorrectly adjusted or calibration has shifted.</p> <p>Gas producer fuel control start derichment too rich.</p>	<p>Replace starter.</p> <p>Review starting procedure.</p> <p>Review starting procedure.</p> <p>Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)</p> <p>Replace fuel nozzle.</p> <p>Check for leaks. Be sure that anti-ice valve is fully closed.</p> <p>Replace bleed control valve.</p> <p>Replace faulty control if start temperature exceeds 927°C (1700°F).</p> <p>Adjust start derichment. (Refer to Adjustments, para 3-82.)</p>
5	Acceleration or lightoff temperature too low during starting.	<p>Fuel control system air sensing lines leaking.</p> <p>Gas producer fuel control incorrectly adjusted or calibration has shifted.</p> <p>Gas producer fuel control start derichment too lean.</p>	<p>Check air lines and fittings for leaks. If available use a liquid leak detector (SNOOP, or equivalent).</p> <p>Replace control.</p> <p>Adjust start derichment. (Refer to Adjustments, para 3-82.)</p>
6	Engine speed cycles at idle.	Gas producer fuel control bypass valve not operating freely.	Disconnect the fuel line at the fuel nozzle, flush system with clean fuel. Inspect and clean the fuel control fuel filter. (Refer to Cleaning the Gas Producer Fuel Control Fuel Filter, para 3-83.) If the same condition still exists, replace control.
7	Engine instability above idle speed.	Contamination in the pneumatic section of the gas producer fuel control and power turbine governor.	Check P <sub>y</sub> port in the governor and the fuel control. Check the P <sub>c</sub> port in the fuel control. Replace control or governor if contaminated.
7A	Engine instability in power range.	Pneumatic leakage	Check for pneumatic leakage. (Refer to Bendix Fuel Control System Pneumatic Leaks Check, para 3-71.) If available use a liquid leak detector (SNOOP, or equivalent).



TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
8	Idle speed too low.	Incorrect gas producer lever setting. Malfunctioning tachometer. Excessive generator load. Dirty compressor.	Check lever position and rigging.  Replace tachometer. Reduce electrical load requirement. Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)
		Gas producer fuel control idle adjustment incorrectly set.	Correct the setting (See figure 3-9.) Adjust cw to increase N <sub>1</sub> speed - 1/8 turn equals approx 5%.
		Air sensing lines leaking.	Check for leaks. Tighten coupling nuts as required.
9	Idle speed too high.	Incorrect gas producer lever setting. Malfunctioning tachometer. Gas producer fuel control idle adjustment incorrectly set.	Check lever position and rigging. Replace tachometer. Correct the setting. (See figure 3-9.) Adjust ccw to decrease N <sub>1</sub> speed - 1/8 turn equals approx 5%.
10	Oil pressure drops off severely.	Oil supply low. Oil pressure transmitter or indicator giving false indication. Regulator valve sticking or broken spring. Defective oil pump.	Check oil supply and refill as necessary. Check transmitter or indicator and repair or replace if necessary. Clean or replace spring.  Inspect or replace pump (or send power and accessories gearbox to an overhaul facility). (Refer to Oil Pump, para 3-170 H.a.)
11	Excessive oil pressure fluctuation.	Air in sensing line.  Gage records inaccurately. Faulty pressure regulating valve. Oil contamination.	Bleed line.  Check gage and transmitter. Replace the valve. Drain and replace filter. Inspect magnetic chip detectors for metallic particles. Thoroughly flush with engine oil while motoring engine. Drain and refill with engine oil.
		Low oil quantity.	Check for excessive consumption.
		Wear of filter housing due to vibration of filter inlet and filter bypass tubes.	Replace the filter housing and/or the O-rings on the inlet and bypass tubes (as required).



TABLE III-5 (cont)

Item	Trouble	Probable Cause	Remedy
12	Low oil pressure	Lack of oil in reservoir. Gage records inaccurately. Oil leaks  Clogged oil filter. Oil pressure not adjusted.  Increase in oil pump internal clearances or sheared drive.  Oil contamination.	Fill reservoir with correct oil Check gage and transmitter. Check all piping connections and the gearbox splitline. (Refer to Gearbox Cover-to-Housing Assembly, para 3-1700, for assembly technique to prevent splitline leakage. Clean or replace oil filter. Adjust oil pressure regulating valve. (Refer to Pressure Regulating Valve, para 3-117.) Inspect or replace pump (or send power and accessories gearbox to an overhaul facility). (Refer to Oil Pump, para 3-170 H.a.) Drain and replace filter. Inspect magnetic chip detectors for metallic particles. Thoroughly flush with engine oil while motoring engine. Drain and refill with engine oil.
13	High oil pressure.	Oil pressure gage and transmitter records inaccurately. Pressure regulating valve improperly adjusted.	Check gage and transmitter. Readjust oil pressure regulating valve.
----- CAUTION -----			
<i>The pressure regulating valve may be adjusted to reduce oil pressure during the initial check run on newly installed engines only. Adjustment to reduce oil pressure on an engine that has been in service is not permitted.</i>			
14	Oil consumption exceeds 0.05 gal (0.19 litre) per hour. (1 quart (1 litre) per 5 hours)	Clogged oil passage(s).  Loose fittings, connections, or splitlines.  Oil leakage from power turbine carbon face seal.  Leaking accessory oil seals as evidenced by oil draining from weep hole (on gas producer fuel control and power turbine governor) or from drain on fuel pump.	Remove engine.  Check all fittings, connections, and splitlines for sealant and proper torque. Wash entire engine and coat with whitener in suspected area. Operate engine to locate source of leakage. (Refer to Gearbox Cover-to-Housing Assembly, para 3-1700, for assembly technique to prevent gearbox splitline leakage.) Replace seal. (Refer to Removal of the Oil Bellows Seal, para 3-156.) Replace defective seals. (Refer to Replacing Oil Seals, para 3-169.)
14A	Oil blowing from gearbox vent.	Leaking accessory pad seal. (Refer to Opened Gearbox Inspection para.)	Replace seal.



**TABLE III-5 (cont)**

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
15	Oil spewing from diffuser vent orifice.	Orifice improperly sized.	Refer to Diffuser Vent Orifice Selection, para 3-177.
15A	Oil spewing at compressor bleed control valve.	No. 1 bearing seal failure.	Replace seal. (Refer to Replacing the Compressor Front Bearing and/or Oil Seal, para 3-146A.)
15B	Oil temperature exceeds limits of para 2-11A.	Oil cooler fan inoperative.	Check fan, repair or replace. Inspect engine. (Refer to Oil Temperature Limit Exceeded, para 3-112A.)
		Oil cooler bypass valve inoperative.	Check valve, repair or replace. Inspect engine. (Refer to Oil Temperature Limit Exceeded, para 3-112A.)
16	Low power with high TOT.	Compressor foreign object damage.	Replace compressor if damage exceeds limits. (Refer to Blade and Vane Inspection, para 3-142.)
		Dirty compressor.	Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)
		Eroded blades, vanes and/or plastic coating.	Replace the case or compressor assembly if erosion exceeds the acceptable limits. (Refer to Blade Damage, Vane Damage and Case Plastic Coating Inspection paragraphs.)
		New compressor case misaligned at installation.	If noise monitoring indicates rub, remove and reinstall the case. (Refer to Case Replacement paragraph.)
		Bleed control valve has failed to close.	Check compressor discharge pressure sensing line for leaks and for security. Clean valve nozzle, filter and jet. (Refer to Bleed Valve Cleaning, para 3-138.)
		Excessive compressor air leaks.	Replace bleed control valve.
		Faulty TOT indicator.	Repair leaks.
		Anti-icing valve leaking.	Replace indicator.
		Heat control valve leaking.	Check linkage or replace valve.
		Faulty torque meter indicating system.	Cap off engine bleed manifold to isolate trouble.
		Cracked first-stage turbine nozzle diaphragm.	Replace gage or transmitter.
			Replace the first-stage turbine nozzle diaphragm (Refer to Replacing the First-stage Turbine Nozzle or First-stage Turbine Nozzle Shield, para 3-153.)



TABLE III-5 (cont)

Item	Trouble	Probable Cause	Remedy
17	Low power with TOT below max limit.	Gas producer control lever does not reach maximum speed adjustment stop.	Adjust linkage to the gas producer fuel control.
		Gas producer control lever maximum speed adjustment stop not properly set.	Correct the maximum speed adjustment setting. Adjust cw to increase N <sub>1</sub> speed – one turn equals approx 1%.
----- CAUTION -----			
<i>This is an overspeed protection setting, move in one turn increments.</i>			
18	Low measured TOT at normal or high power.	Loose pneumatic fitting or cracked pneumatic line causing an air leak in the control system.	Pressurize the system to check for leaks. (Refer to Fuel Control System Pneumatic Leak Check, para 3-71.)
		Faulty TOT indicator.	Replace indicator.
19	Engine N <sub>1</sub> or N <sub>2</sub> overspeeds.	Faulty TOT thermocouple assembly.	Replace thermocouple assembly. (Refer to Thermocouples, para 3-130.)
		Gas producer fuel control linkage not properly set.	Check linkage for proper operation and adjustment.
19	Engine N <sub>1</sub> or N <sub>2</sub> overspeeds.	Defective propeller, gas producer fuel control, or power turbine fuel governor.	Replace defective control or governor.
		Faulty N <sub>1</sub> or N <sub>2</sub> tachometer.	Replace generator or indicator.
19	Engine N <sub>1</sub> or N <sub>2</sub> overspeeds.	Defective propeller overspeed governor.	Replace propeller overspeed governor assembly.
		----- NOTE -----	
<i>During ground run after overspeed incident, note the idle speed with the power lever at the 30° position. If the idle speed is normal, suspect the propeller or power turbine governor – if idle speed is high, suspect the gas producer fuel control as the faulty component.</i>			
20	Excessive exhaust torching during transients.	Fuel nozzle malfunction.	Replace fuel nozzle.
		Excessively rich gas producer fuel control.	Replace control.
21	Slow to accelerate from idle to power.	Leaking accessory bleed lines.	Repair or replace lines.
		Dirty compressor.	Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)
		Eroded blades, vanes and/or plastic coating.	Replace the case or compressor assembly if erosion exceeds the acceptable limits. (Refer to Blade Damage, Vane Damage and Case Plastic Coating Inspection paragraphs.)



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TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
21	Slow to accelerate from idle to power. (Cont'd.)	New compressor case misaligned at installation.	If noise monitoring indicates rub, remove and reinstall the case. (Refer to Case Replacement paragraph.)
		Bleed control valve malfunctioning	Replace bleed control valve.
		Loose pneumatic fittings.	Tighten or replace as required.
		Excessive generator load.	Reduce electrical load.
		Excessive compressor air leakage.	Check for leaks and repair.
22	Slow to accelerate to power while in flight.	Gas producer control acceleration schedule too lean.	Replace control.
		Same as in preceding trouble.	Correct as in preceding Trouble.
23	TOT approx 30°C lower than normal at idle.	Governor linkage incorrectly rigged.	Check rigging. Correct linkage as required.
		Bleed control valve stuck closed.	Replace bleed control valve.
24	Compressor surge during starting or near the idle speed.	Dirty compressor.	Clean compressor and bleed valve. (Refer to Compressor Cleaning and Bleed Valve Cleaning, para 3-29 and 3-138.)
		Eroded blades, vanes and/or plastic coating.	Replace the case or compressor assembly if erosion exceeds the acceptable limits. (Refer to Blade Damage, Vane Damage and Case Plastic Coating Inspection paragraphs.)
		New compressor case misaligned at installation.	If noise monitoring indicates rub, remove and reinstall the case. (Refer to Case Replacement paragraph.)
25	Compressor surge during starting.	Excessively rich gas producer fuel control.	Replace gas producer fuel control.
		Bleed control valve stuck closed.	Replace bleed control valve.
		Bleed control valve has failed to open.	Replace bleed control valve.
26	Compressor surge during acceleration.	Excessively rich gas producer fuel control.	Replace gas producer fuel control.
		Bleed control valve has failed to open.	Replace bleed control valve.
27	Compressor surge during low power operation.	Excessively rich gas producer fuel control.	Replace gas producer fuel control.
		Bleed control valve has failed to open.	Clean bleed valve filter, jet and strainer. If condition still exists, replace bleed control valve. (Refer to Bleed Valve Cleaning, para 3-138.)
		Eroded blades, vanes and/or plastic coating.	Replace the case or compressor assembly if erosion exceeds the acceptable limits. (Refer to Blade Damage, Vane Damage and Case Plastic Coating Inspection paragraphs.)
		New compressor case misaligned at installation.	If noise monitoring indicates rub, remove and reinstall the case. (Refer to Case Replacement paragraph.)



TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
28	More than 20 drops per minute fuel leaking from overboard drain ports.	Fuel pump drive shaft seal leaking.	Replace fuel pump.
29	Faulty torquemeter indication.	Gas producer fuel control failure.	Replace fuel control.
		Clogged torquemeter bleed orifice.	Clean orifice or send gearbox to an overhaul facility. (Refer to applicable part of Gearbox Disassembly and Assembly, para 3-170A, for assembly procedure.)
		Clogged torquemeter pressure sensing oil passage.	Flush passage or send gearbox to an overhaul facility. (Refer to applicable part of Gearbox Disassembly and Assembly, para 3-170A, for assembly procedure.)
30	Lack of anti-icing air.	Torquemeter supporting bearing failure.	Replace bearing or send gearbox to an overhaul facility. (Refer to applicable part of Gearbox Disassembly and Assembly, para 3-170A, for assembly procedure.)
		Defective anti-ice air lines.	Check lines.
		Anti-icing air valve stuck closed. Dirt collected in vane trailing slot.	Replace valve. Remove anti-icing air lines at the compressor front support, cap the bullet nose outlet holes and blow through struts and out slots at 40 psig (276 kPa) maximum.
31	Continuous exhaust smoking.	Oil leakage from forward compressor bearing oil seal or power turbine carbon face seal.	If oil consumption exceeds limits, replace faulty component.
32	Compressor rear bearing labyrinth seal vent smoking.	Seal vent orifice improperly sized or improperly seated.	Replace or repair vent orifice. (Refer to Diffuser Vent Orifice Selection, para 3-177.)
33	Engine power reset to the takeoff setting.	Aircraft gas producer linkage broken or disengaged.	Replace linkage or reconnect.
34	Exhaust duct emitting sparks.	Combustion liner damaged.	Inspect combustion liner and repair or replace. (Refer to Combustion Liner Inspection, para 3-161.)
		Turbine or compressor blade, vane, or seal damaged.	Replace faulty component.
35	Excessive vibration.	Loose engine mounts.	Inspect for security and condition of mounts.
		Turbine wheel blade failure.	Inspect the turbine wheel blades. (Refer to Blade and Vane Inspection para 3-150.)
		Compressor damage.	Check visible sections of the compressor.
		Bearing failure or accessories section internal failure.	Check the magnetic inspection plugs for particles. If accumulated particles are found, send engine to overhaul.
		Cause uncertain.	Install engine in another aircraft or in test stand for comparison. Send engine to overhaul if excessive vibration persists.



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TABLE III-5 (cont)

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
36	Unable to stop engine.	Gas producer fuel control fuel cutoff valve not closed.	Close the aircraft fuel shutoff valve to stop the engine. Then check control linkage rigging or replace gas producer fuel control if faulty.
37	Afterfire.	Oil leak.	See trouble condition Oil Leakage During Shutdown Periods.
		Burner drain valve line obstruction.	Check the drain lines. Clean or replace as necessary.
		Sticking burner drain valve.	Replace valve.
		Fuel nozzle valve stuck open.	Replace fuel nozzle.
38	Heavy smoking out exhaust following engine shutdown (light wisps of smoke are normal and not cause for engine rejection unless oil consumption limits are exceeded).	Gas producer fuel control cutoff valve not fully closed.	Check linkage or replace fuel control.
		Oil seepage past No. 5 bearing oil bellows seal into hot exhaust and collector.	If suspected, visually inspect for evidence of puddling in bottom of exhaust collector after engine has been inoperative. If leakage is present, replace No. 5 bearing oil bellows seal (Refer to replacement para 3-156 and 3-157.)
		Oil seepage past turbine oil check valve onto hot turbine.	Remove and inspect turbine check valve. (Refer to Turbine Pressure Oil System Check Valve, para 3-118.)
		Residual oil in No. 6 and 7 bearing area, depositing on hot turbine parts.	Remove external sump; inspect and clean strut. (Refer to Inspection and Cleaning of Power Turbine Support Scavenge Oil Strut, para 3-115A.)
		Excessive clearance of rotating knife seals located in No. 6 and 7 bearing area.	This is usually accompanied by low power. If suspected, replace turbine.
39	Static oil leakage from power and accessories gearbox breather.	Oil leakage in aircraft scavenge oil check valve.	Oil can be found leaking from the outer combustion case after the engine has been inoperative for an extended period.
		Internal check valve stuck open.	Clean or replace the internal check valve. (Refer to Replacing the Lube Oil Filter Housing, para 3-119.)  Remove filter housing and inspect housing and transfer tubes (2) mating surfaces. Check O-rings on housing end of transfer tubes. Replace defective items.
40	Oil leaking from weep holes at gas producer fuel control and/or power turbine fuel governor.	Check engine oil seal.	Replace leaking seal.
41	Starter unable to rotate engine immediately after shutdown.	Turbine blade tip clearance.	If engine will rotate after cooldown, no corrective action required. If unable to rotate engine after cooldown, remove turbine for further examination.
		Binding at the rear diffuser seal.	Replace compressor.



**TABLE III-5 (cont)**

<i>Item</i>	<i>Trouble</i>	<i>Probable Cause</i>	<i>Remedy</i>
41A	Starter unable to rotate engine.	Binding of compressor, turbine or gearbox.	Determine which major component is binding; replace component or engine.
42	Propeller does not rotate by 25% $N_1$ speed during start.	Turbine blade tip ( $N_2$ ) rub.	Shut down. Repeat start procedure. If not rotating after second attempt, turn the propeller by hand (either direction) before again repeating the start procedure. (Refer to Item 42 NOTE.) Replace turbine if condition persists.
		Carbon formation around rotating labyrinth seals.	Ensure that the oil being used is MIL-L 7808F or G, or MIL-L23699. Shut down. Repeat start procedure. If not rotating after second attempt, turn the propeller by hand (either direction) before again repeating the start procedure. (Refer to Item 42 NOTE.) If the propeller cannot be turned by hand, clean carbon from rotating labyrinth seals. (Refer to Cleaning Power Turbine Labyrinth Seals, para 3-115B.)

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**NOTE**  
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*To help alleviate turbine rub or carbon conditions which prevent the propeller ( $N_2$ ) from turning by 25%  $N_1$  speed, turn the propeller (either direction) by hand after a start attempt and/or while the engine is cooling down. If chatter is encountered, stop turning the propeller. Repeat the procedure at the next convenient shutdown.*

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43	Metal chips on magnetic drain plug and/or noise at compressor front bearing.	No. 1 bearing failure.	Replace No. 1 bearing using applicable part of Replacing the Compressor Front Bearing and/or Oil Seal, para 3-146A.)
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**3-50. INSPECTIONS.**

3-51. The inspection requirements for the engine have been categorized into Scheduled Inspections and Special Inspections.

**3-52. SCHEDULED INSPECTIONS.**

3-53. Scheduled inspections are made at periodic intervals in an effort to prevent engine malfunction and serve in the role of preventive maintenance for the engine. The component to be inspected, the nature of the inspection,

and the elapsed time after which the inspection is to be performed are given in table III-6. The inspection times are in hours of engine operation.

**3-53A. SPECIAL INSPECTIONS.**

3-53B. Special inspections are required when the engine has been subjected to abnormal operating conditions, when engine damage is suspected, or when associated parts are removed from the engine. The special occurrence, the component or system to be inspected, and the nature of the inspection are given in table III-6A.



**3-54. SUDDEN STOPPAGE INSPECTION.**

3-55. The following inspections must be satisfactorily completed whenever the propeller strikes a stationary object.

- a. Inspect engine mounts for security, cracks, or misalignment. If stoppage was severe enough to fracture an engine mount, send the engine to overhaul.
- b. Inspect magnetic plugs for metal accumulation.
- c. Inspect the compressor blades and vanes for foreign object damage.
- d. Inspect the engine inlet for foreign objects.
- e. Rotate the propeller by hand and check for unusual noise.
- f. Motor the engine and check for unusual noise.
- g. Operate the engine for 30 minutes on the ground then check the magnetic plugs for metal accumulation.

**3-55A. HARD LANDING LIMITS.**

3-55B. Make a visual inspection of the installed engine for external damage from airframe components after any hard landing. Engines that have sustained landing forces exceeding 10g shall be sent to an overhaul facility.

**3-56. COMPRESSOR INLET AIR BLOCKAGE.**

3-57. Replace the compressor assembly if the engine has been operated with inlet air restricted due to foreign objects or materials which have become lodged in the compressor inlet. Tag the replaced compressor to show that the cause of removal was inlet air blockage. Conditions which constitute blockage are as follows:

- a. Foreign objects or materials found in the inlet during inspection of the aircraft when not in operation. If it can be determined that the blockage was not there during the last operation of the engine, remove the foreign object or material and leave the compressor in service.
- b. Power loss encountered following a restriction at the compressor inlet area while the engine is in operation. Blockage in flight can usually be verified by inspection after landing (blockage still exists). However, some blockage may be followed by ingestion before inspection can take place. Objects or materials which were large enough to have stopped at the inlet guide vanes before ingestion, or which cause a noticeable raise in TOT, can be considered to have caused compressor inlet blockage.

**3-57A. ENGINE SUBMERGED WHILE IN OPERATION.**

3-57B. If the engine has been submerged in water while in operation, proceed as follows:

- a. Flag the engine indicating that it encountered submersion while in operation.

b. Return the entire engine to an overhaul facility as soon as possible for replacement of all compressor and turbine wheels.

**3-58. HOT START INSPECTION.**

3-59. When the engine starting temperature limits of tables II-1, II-1A or II-2 are exceeded and turbine inspection is the recommended maintenance action, proceed as follows:

- a. Remove the outer combustion case and combustion liner. (Refer to Replacing the Combustion Liner, para 3-162.)
- b. Inspect the nozzle in accordance with items 1 and 2 of table III-8.
- c. Reassemble the engine. (Refer to Replacing the Combustion Liner, para 3-162.)

3-59A. Center-Slotted Third-Stage Turbine Wheels. Center-slotted turbine wheels P/N 6898551, 6898567, 6898733, 6898743, 6898753 or 6898763 which have encountered known or recorded hot starts exceeding 810-927°C (1490-1700°F) for 10 seconds maximum or 927°C (1700°F) peak shall be replaced. Record the event, temperature and duration in Part I of the Engine Log. Return these Engine Log pages and the turbine to an Overhaul Agency for replacement of the third-stage turbine wheel.

**3-60. SNOW INGESTION INSPECTION.**

3-61. Inspect the engine for snow, ice, or water damage as follows:

- a. Obtain access to the compressor inlet but do not disassemble any engine parts.
- b. Replace the compressor assembly if any mechanical damage, distortion, or bending is detected on the compressor front support vanes or first-stage rotor blades.

**3-62. EROSION INSPECTION.**

3-63. If the aircraft is frequently subjected to sand or dust ingestion, inspect compressor blades, vanes and plastic for erosion. (Refer to Blade Damage, Vane Damage, Case Plastic Coating Inspection and Case Replacement, para 3-143, 3-144, 3-145 and 3-146.

**3-63A. LIGHTNING STRIKE INSPECTION.**

3-63B. If the airframe has been subjected to a known or suspected lightning strike and evidence of that strike can be found on the propeller, flag the engine and send it to an overhaul facility. A complete lightning strike inspection of the engine must be performed at the overhaul facility.



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TABLE III-6

### Scheduled Inspections

Item	Component	Interval					
		Preflight	Postflight*	50 hr	100 hr	300 hr	Other
ENGINE ASSEMBLY							
1	Engine, general	a, b, bA c					
2	Control Linkage						
COMPRESSOR							
3	Blades and vanes		d, dA				
3A	Case					dB	dB (1750 hr)
TURBINE							
4	Supports and ducts				e	eA(250-B17B)	f (250-B17)
4A	Wheels						fA
COMBUSTION SECTION							
5	Burner drain valve				g		
GEARBOX							
6	Starter-generator gearshaft					h	
7	Magnetic drain plugs				i		
8	Compressor mount inserts and attaching bolts.				j		
IGNITION							
9	Lead				k		
10	Start counter				l		
LUBRICATION							
11	Oil supply	m	mA				n
FUEL							
12	Fuel pump filter					o	
13	Fuel pump						p (750 hr)
14	Fuel system, general		q				
15	Fuel nozzle					r	
16	Fuel control						s (1000 hr)

\* Postflight inspections shall be made after the final flight of the day.

-----  
**NOTE**  
 -----

The letter designations in the Interval Column refer to the applicable Description of the Inspection.

-----



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TABLE III-6 (cont)

	Description of Inspection
<b>Item 1. Engine, General</b>	
a.	Inspect the entire engine for loose bolts, broken or loose connections, security of mounting accessories, and broken or missing lockwire. Check accessible area for obvious damage and evidence of fuel or oil leakage.
b.	Check to ascertain that mounting and support bolts are tight, lockwired, and in good condition. Check security of screws and rivets. Remove all foreign material which might be drawn into the compressor inlet.
bA.	After the propeller or the engine has been removed and/or replaced, purge the air from the prop oil system by cycling the prop through its operating range. (Refer to Propeller Check Run, para 3-180A.)
<b>Item 2. Control Linkage</b>	
c.	Check for freedom of operation and full travel. Check security of linkage. Check for excessively loose or worn linkage and linkage bolts.
<b>Item 3. Compressor Blades and Vanes</b>	
d.	Any time the aircraft has been operated in an atmosphere known (or suspected) to be corrosive, perform a water rinse of the compressor. (Refer to Compressor Salt Water Contamination Removal, para 3-30.)
dA.	Inspect for obvious foreign object damage.
<b>Item 3A. Compressor Case</b>	
dB.	Inspection frequency shall be as made necessary by operating environment. In an erosive environment, inspect case at least every 300 hours. In any environment, do not exceed 1750 hours without case inspection. (Refer to Erosion Inspection, para 3-62.)
<b>Item 4. Turbine Supports and Ducts</b>	
e.	Inspect the turbine support assemblies and engine exhaust ducts for condition of welded joints, for cracks, and for buckling. (Refer to Turbine and Exhaust Collector Support Crack Repair, para 3-155.)
eA.	Inspect the oil passage inside the bottom strut of the power turbine support unless previous experience dictates an earlier or a later time interval. (Refer to Inspection and Cleaning of Power Turbine Support Scavenge Oil Strut, para 3-115A.)
f.	Inspect the oil passage inside the bottom strut of the power turbine support if carbon is found in the oil filter or N <sub>2</sub> bind is encountered. (Refer to Inspection and Cleaning of Power Turbine Support Scavenge Oil Strut, para 3-115A.)
<b>Item 4A. Turbine Wheels</b>	
fA.	See Model 250 Commercial Service Letters TP CSL-1004 and -1005 for 250-B17 TBO and life limits. See Model 250 Commercial Service Letters TP CSL-1015 and -1016 for 250-B17B TBO and life limits.
<b>Item 5. Burner Drain Valve</b>	
g.	Clean the burner drain valve. (Refer to Burner Drain Valve, para 3-166.)
<b>Item 6. Gearbox - Starter-generator Gearshaft</b>	
h.	Starter-generator gearshafts which have been replaced in accordance with Commercial Engine Bulletin 250-B17/-17B TP CEB 1056 do not need periodic inspection and lubrication. Clean and inspect any other starter-generator gearshaft. Clean the female splines of the starter-generator gearshaft and the male splines of the starter generator with mineral spirits and a soft brush. Dry splines; then check gearshaft splines for wear using 23002204 spline gage (no go). Replace gearshaft if gage fits into spline. Lubricate acceptable splines with grease (Aeroshell No. 22, or equivalent). Prior to reinstallation of the gearshaft, determine that the torsional damper members of the gearshaft are in hard contact with each other.



TABLE III-6 (cont)

**Item 7. Magnetic Drain Plugs**

- i. Inspect plugs for residue of extremely fine metal at intervals of 25-100 hours. Clean accumulation from plug using solvent. Use a brush to dislodge all debris. Wipe plug dry using a clean cloth. As an optional drying method, use compressed air. (Refer to Magnetic Plug Inspection, para 3-120.)

----- **NOTE** -----

*A gradual accumulation of extremely fine metal containing no chips or flakes and having a grayish paste appearance is a normal condition. This accumulation is not cause for engine removal but it must be cleaned from the plug to make certain that small chips or flakes can be detected. If large amounts of metallic paste are encountered, increase the frequency of the inspection and cleaning operation.*

**Item 8. Gearbox – Compressor Mount Inserts and Attaching Bolts**

- j. Inspect inserts for evidence of looseness or for oil leakage. Replace if loose. (Refer to Repair of Compressor Mounting Inserts, para 3-167B.) Check security of the five compressor attaching bolts.

**Item 9. Ignition Lead**

- k. Inspect ignition lead for burning, chafing, or cracking of conduit and loose connectors and broken lockwire. (Refer to Spark Igniter Lead, para 3-126.)

**Item 10. Start Counter**

- l. Check operation. Verify operation during next scheduled start.

**Item 11. Oil Supply**

- m. Check oil supply level.
- mA. Check oil quantity immediately after shutdown (before oil has had time to drain into the gearbox).
- n. Change oil in accordance with 250-B17 TP CSL-1002.

**Item 12. Fuel Pump Filter**

- o. If the aircraft is equipped with an engine fuel filter differential pressure warning system, replace the throw-away fuel filter when an indication of filter contamination is obtained or every 300 hours, whichever comes first. If the aircraft is not equipped with an engine fuel filter differential pressure warning system, replace the fuel filter every 300 hours unless operating experience demonstrates that smaller time increments are advisable. (Refer to Fuel Pump and Filter Assembly, para 3-77.)

----- **CAUTION** -----

*When there is evidence that the fuel pump filter has been bypassed, inspect and clean the fuel filter in the fuel control. If contamination is not found, make a 10 minute ground run of the engine to ensure proper operation of the control and governor. Replace the O-ring each time the filter fittings are removed. Install the fuel control filter with the open end facing out. (Refer to the Fuel System Filter Maintenance, para 3-72.)*

**Item 13. Fuel Pump**

- p. Check the fuel pump drive shaft on Sundstrand pumps for spline wear. (Refer to Single Element Fuel Pump Drive Shaft Inspection, para 3-80A.)

----- **NOTE** -----

*This inspection is not required on TRW pumps.*

**Item 14. Fuel System, General**

- q. Check the accessible fuel system components, lines, and connections for evidence of insecurity or leakage. Accomplish with the boost pump on if available.

**Item 15. Fuel Nozzle**

- r. Clean and inspect the fuel nozzle in accordance with Fuel Nozzle, para 3-73 through 3-75.

**Item 16. Fuel Control**

- s. If Commercial Engine Bulletin TP CEB-1062 has not been complied with, replace fuel strainer at intervals not exceeding 1000 hours TSN or TSLO. (Refer to applicable part of Cleaning the Gas Producer Fuel Control Fuel Filter, para 3-83 for the replacement procedure.)



TABLE III-6A

<b>Special Inspections</b>			
<i>Item</i>	<i>Occurrence</i>	<i>Component or System</i>	<i>Required Action</i>
1	Engine removal from aircraft	Engine, general	a, cA
2	Compressor removal from engine	Anti-icing valve Gearbox compressor mounts inserts Turbine-to-compressor coupling	k t ae
3	Turbine removal from engine	Combustion liner Outer combustion case Compressor discharge air tubes Turbine pressure oil check valve Burner drain valve Turbine-to-compressor coupling	q p r z r ae
4	Turbine separation at exhaust collector-to-power turbine support		ae
5	Rigid tube removal from engine	Rigid tube	d
6	Hard landing (over 10g)	Engine, general	b
7	Sudden stoppage of propeller	Engine, general Compressor Magnetic drain plugs	c g u
8	Operation in erosive environment	Compressor	i
9	Snow or ice ingestion	Compressor	f
10	Foreign object damage	Compressor Turbine	h l
11	Operation with inlet restricted	Compressor	e
12	Overtemperature operation	Turbine Thermocouples	m o
13	Hot start encountered	Turbine	n
14	Oil temperature limit exceeded	Oil system	x
15	Fuel filter by-passed	Fuel control fuel filter Fuel pump filter	ab aa
16	Oil change	Oil System Oil filter	v y
17	Engine inactive more than 5 days	Compressor	j
18	Engine inactive more than 30 days	Oil system	w
19	As dictated by performance	Fuel control P <sub>c</sub> filter System P <sub>c</sub> filter	ac ad
20	Engine submerged while in operation	Compressor Turbine	eA nA
21	Known or suspected lightning strike on aircraft	Engine, general Propeller, general	cB cB

----- NOTE -----

The letter designations in the Required Action column refer to the applicable Description of Inspection.

-----



TABLE III-6A (cont)

Engine, General	Description of Inspections
	<ul style="list-style-type: none"><li>a. Any time the engine is removed from the aircraft, inspect the compressor inlet for foreign object damage or condition. Clean and flush all aircraft drain lines. Wash the outside of the engine with mineral spirits. Touch up paint where peeling or chipping is evident. (Refer to Corrosion Treatment and Surface Finish Repair, para 3-31.)</li><li>b. After a hard landing, inspect the complete engine. (Refer to Hard Landing Limits, para 3-55A.)</li><li>c. After sudden stoppage of the propeller due to striking a stationary object, inspect the engine mounts for security, cracks, or misalignment. Motor the engine and check for unusual noise. (Refer to Sudden Stoppage Inspection, para 3-54.)</li><li>cA. Purge trapped air from the propeller oil system and subject the engine to reverse propeller operation on the ground prior to the first flight anytime the propeller or the engine has been replaced. (Refer to Propeller Check Run, para 3-180A.)</li><li>cB. After a known or suspected lightning strike on the aircraft, inspect/repair the propeller in accordance with applicable propeller service instructions. If evidence of a strike is found on the propeller, inspect the complete engine. (Refer to Lightning Strike Inspection, para 3-63A.)</li></ul>
	<p><b>Rigid Tubes</b></p> <ul style="list-style-type: none"><li>d. Inspect rigid tubes any time they are removed. Replace tube if any cracks (dye check) are detected or if the tube has kinks or dents which could affect seating or integrity. (Refer to Rigid Tube Installation, 3-21.)</li></ul>
	<p><b>Compressor</b></p> <ul style="list-style-type: none"><li>e. After engine operation with inlet air restricted due to foreign objects, replace the compressor. (Refer to Compressor Inlet Air Blockage, para 3-56.)</li><li>eA. If the engine is submerged in water while in operation, return the complete engine to an overhaul facility for replacement of all compressor and turbine wheels. (Refer to Engine Submerged While in Operation, para 3-57A.)</li><li>f. After engine operation in snow, ice, or water, inspect the compressor inlet (without disassembly of engine parts) for damage due to ingestion of snow or ice buildup. (Refer to Snow Ingestion Inspection, para 3-60.)</li><li>g. After sudden stoppage of the propeller due to striking a stationary object, inspect the compressor inlet for foreign object damage. Also, inspect the compressor rotor blades and stator vanes. (Refer to Sudden Stoppage Inspection, para 3-54.)</li><li>h. After suspected foreign object damage, inspect the compressor rotor blades and stator vanes. (Refer to Blade Damage, and Vane Damage, para 3-143 and 3-144.)</li><li>i. After engine operation in an erosive environment, inspect compressor blades, vanes, and plastic for erosion. (Refer to Erosion Inspection, para 3-62.)</li></ul> <p style="text-align: center;">----- <b>NOTE</b> -----</p> <p><i>If the aircraft is subjected to sand or dust ingestion, periodic compressor erosion inspection is recommended. The frequency of the inspection should be based on the frequency and degree of ingestion and condition of the compressor at the last inspection. Experience has shown that the bottom half of the compressor case is more prone to erosion.</i></p> <p>-----</p> <ul style="list-style-type: none"><li>j. If the engine will be shut down for more than 5 calendar days, preserve the compressor. (Refer to Compressor Preservation, para 3-45.)</li></ul>
	<p><b>Anti-icing Valve</b></p> <ul style="list-style-type: none"><li>k. Any time the compressor is removed from the engine, inspect the anti-icing air valve for wear or damage. (Refer to Anti-icing Air Valve, para 3-133.)</li></ul>
	<p><b>Turbine</b></p> <ul style="list-style-type: none"><li>l. After suspected foreign object damage, inspect the first-stage turbine blades and vanes. (Refer to Blade and Vane Inspection, para 3-142.)</li><li>m. After engine operation at temperatures exceeding the operating limits requiring turbine inspection in table II-1, inspect the first-stage turbine nozzle in accordance with table III-8; items 1 and 2. Record temperature and duration in the Engine Log.</li></ul>



**TABLE III-6A (cont)**

n. After exceeding the starting temperature limits of table II-1, where turbine inspection is the recommended action, inspect the first-stage turbine nozzle in accordance with table III-8, items 1 and 2. (Refer to Hot Start Inspection, para 3-58 and Center Slotted Third-stage Turbine Wheels, para 3-59A.) Record temperature and duration in the Engine Log.

nA. If the engine is submerged in water while in operation, return the complete engine to an overhaul facility for replacement of all compressor and turbine wheels. (Refer to Engine Submerged While in Operation, para 3-57A.)

**Thermocouples**

o. After engine operation at temperatures exceeding the operating limits requiring turbine inspection in table II-1, inspect the thermocouples. (Refer to Thermocouples, para 3-130.)

**Outer Combustion Case**

p. Any time the turbine is removed from the engine, inspect the outer combustion case. (Refer to Outer Combustion Case Inspection, para 3-164.)

**Combustion Liner**

q. Any time the turbine is removed from the engine, inspect the combustion liner. (Refer to table III-9.)

**Compressor Discharge Air Tubes**

r. Any time the turbine is removed from the engine, inspect the compressor discharge air tubes for dents, cracks or wear. (Refer to Compressor Discharge Air Tubes, para 3-165.)

**Burner Drain Valve**

s. Any time the turbine is removed from the engine, remove, clean and inspect the burner drain valve. (Refer to Burner Drain Valve, para 3-166.)

**Gearbox**

t. Any time the compressor is removed from the engine, inspect the mounting inserts on the gearbox for looseness. (Refer to Insert Inspection, para 3-167A.)

**Magnetic Drain Plugs**

u. After sudden stoppage of the propeller due to striking a stationary object, inspect the magnetic plugs for metal accumulation. (Refer to Sudden Stoppage Inspection, para 3-54.)

**Oil System**

v. Drain oil from the system and refill using the oils and time interval specified in 250-B17 TP CSL-1002. Remove, clean, and reinstall the oil filter at each oil change.

w. Inspect the oil filter for contamination after 10 hours operating time on any engine that has not been operated for 30 days or more. Clean oil filter and change system oil if inspection indicates a need.

x. Any time the engine oil temperature limit has been exceeded, take the appropriate maintenance action given in Oil Temperature Limit Exceeded, para 3-112A.)

**Oil Filter**

y. At each oil change, remove, clean, and reinstall the oil filter. (Refer to Oil Filter, para 3-116.)

**Turbine Pressure Oil System Check Valve**

z. Any time the turbine is removed from the engine, clean and inspect the check valve. (Refer to Turbine Pressure Oil System Check Valve, para 3-118.)



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TABLE III-6A (cont)

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**Fuel Pump Filter**

- aa. If the aircraft is equipped with an engine fuel filter differential pressure warning system, the fuel filter need be changed only when an indication of filter contamination is obtained. If the aircraft is not equipped with an engine fuel filter differential pressure warning system, replace the fuel filter every 300 hours unless operating experience demonstrates that smaller time increments are advisable.

----- **CAUTION** -----

*When there is evidence that the fuel pump filter has been bypassed, inspect and clean the fuel filter in the fuel control. If contamination is not found, make a 10 minute ground run of the engine to ensure proper operation of the control and governor. Replace the O-ring each time the filter fittings are removed. Install the fuel control filter with the open end facing out. (Refer to the Fuel System Filter Maintenance, para 3-72.)*

**Fuel Control Fuel Filter**

- ab. Any time fuel pump filter bypass is known or suspected to have taken place, inspect and, if required, clean the fuel filter element in the gas producer fuel control. (Refer to Cleaning the Gas Producer Fuel Control Fuel Filter, para 3-83.)

**Fuel Control P<sub>c</sub> Filter**

- ac. When dictated by engine performance, clean and reinstall the fuel control P<sub>c</sub> filter. (Refer to paragraph 3-92.)

**Fuel System P<sub>c</sub> Filter**

- ad. When dictated by engine performance, remove, clean and reinstall the fuel system P<sub>c</sub> Filter. (Refer to P<sub>c</sub> Filter, para 3-76.)

**Turbine-to-Compressor Coupling**

- ae. After (1) compressor removal, (2) turbine removal, or (3) turbine separation at the exhaust collector-to-power turbine support, inspect the splines on both ends of the coupling using a scribe. Run the scribe across the spline surfaces to check for a wear step. Reject the coupling if the pointed object catches on the wear step. Polished spline surfaces are acceptable. If there is any doubt on the amount (or depth) of the wear step, reject the coupling.
-



**3-64. SYSTEMS MAINTENANCE.**

3-65. Systems maintenance includes the inspections, cleaning, replacements, and adjustments accomplished on the items making up the major systems of the engine.

----- **CAUTION** -----

*Before removing the engine from the airframe, remove, clean and reinstall the fuel control-to-governor P<sub>y</sub> tube (P/N6853435). If the engine is inverted (as in the turnover stand) before the residual oil has been removed from the P<sub>y</sub> tube, this oil will enter and contaminate the fuel control.*

**3-66. FUEL, CONTROL AIR, AND OIL TUBES.**

- 3-67. Inspect tubes for dents, chafing, or cracks.
- Reject tubes with cracks (dye check) in any area.
  - Reject tubes having dents or chafing on the flared ends or at the retention clamps.
  - Reject tubes with dents exceeding 1/8 in. (3.2 mm) depth or having a sharp radius.

**3-68. POWER CONTROL SYSTEM.**

3-69. Power control system maintenance consists of checks, adjustments, cleaning, servicing, and replacement of the various system components. These functions can be performed with common hand tools and the recommended special service tools. Figure 3-3 illustrates the components which make up the power control system.

**3-70. Purging the Fuel System.** Maintenance of the fuel system can result in air entrapment in the fuel lines and subsequent false starts. Following maintenance, purge the air from the fuel system as follows:

----- **CAUTION** -----

*Before purging the air from the control system, be sure to ground the aircraft.*

- Disconnect the input to the ignition exciter.
- Disconnect the line to the fuel nozzle; place the open end of the line in a bucket.
- Move the condition lever to the maximum (100% propeller speed) position.

- Motor the engine until a solid stream of fuel flows from the disconnected line.
- Move the condition lever to the FUEL OFF-FEATHER position.
- Reconnect the fuel line and the input to the ignition exciter.

----- **NOTE** -----

*If any fuel system component (including piping) is removed/installed or any line is opened during maintenance, check the pneumatic portion of the control system for leaks. (Refer to Fuel Control System Pneumatic Leak Check, para 3-71.)*

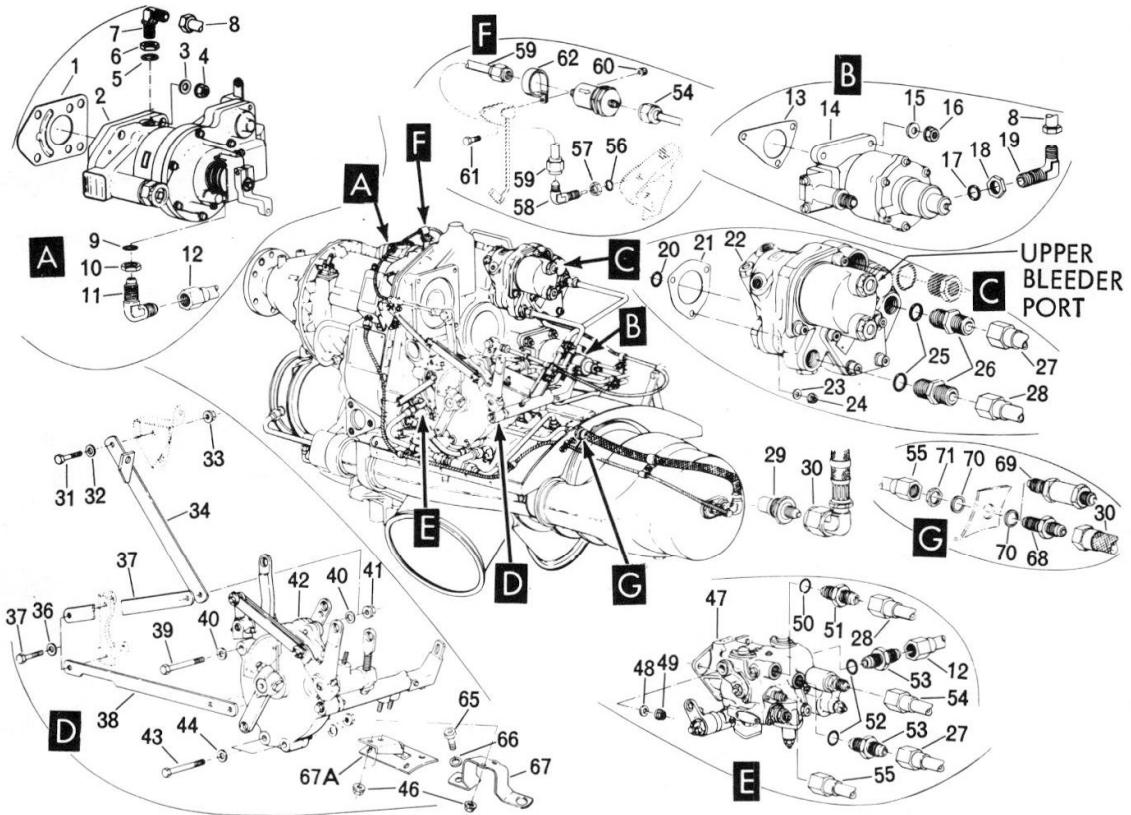
**3-71. Fuel Control System Pneumatic Leak Check.**

Check the pneumatic portion of the fuel control system for leaks as follows:

- Disconnect the pressure sensing line between the scroll and the P<sub>c</sub> filter. Hold the filter while loosening the coupling nut.
- Apply 50-80 psi (345-552 kPa) filtered (10 micron) air to the P<sub>c</sub> filter.
- Use a liquid soap solution to check all fittings and lines in the system for leaks. No leakage is acceptable. Clean the soap solution from the engine after the check is completed. Reinstall P<sub>c</sub> tube. Tighten coupling nuts to 80-120 lb in. (9.04-3.56 N·m). Hold the P<sub>c</sub> filter while tightening the coupling nut.

**3-72. Fuel System Filter Maintenance.** The filters which are maintained as a part of the engine assembly fuel system include; a fuel pump fuel filter and a gas producer fuel control fuel filter. In addition to the fuel filters, the control system has a P<sub>c</sub> air filter in the fuel control and a P<sub>c</sub> filter in the pressure sensing line coming from the diffuser scroll.

- Fuel Pump Filter. The fuel pump filter element is replaceable and has a 5 micron nominal/15 micron absolute rating. Aircraft having a differential pressure (bypass) warning system shall have the pump filter replaced when a warning light is observed. Aircraft that are not equipped with the bypass warning system shall have the pump filter replaced every 300 hours. (Refer to Fuel Pump and Filter Assembly, para 3-77.)



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- |  |   |  |  |
|--|---|--|--|
| 1. Gasket  | 17. O-ring  | 35. Bolt (2)                                       | 55. Fuel Control-to-Fire Shield Tube                     |
| 2. Propeller-Power Turbine Governor              | 18. Nut   | 36. Washer (2)                                     | 56. O-ring   |
| 3. Washer (4)                                    | 19. Elbow   | 37. Support Upper Bracket                          | 57. Nut  |
| 4. Nut (4)                                       | 20. O-ring  | 38. Support Lower Bracket                          | 58. Pressure Probe Elbow                                 |
| 5. O-ring  | 21. Gasket  | 39. Bolt   | 59. Scroll-to-P <sub>c</sub> Filter Air Tube             |
| 6. Nut   | 22. Fuel Pump and Filter Assembly                   | 40. Washer (2)                                     | 60. Nut  |
| 7. Elbow   | 23. Washer (3)                                      | 41. Nut  | 61. Bolt   |
| 8. Overspeed Governor Servo Oil Tube             | 24. Nut (3)   | 42. Coordinator                                    | 62. Clamp  |
| 9. O-ring  | 25. O-ring (2)                                      | 43. Bolt (2)                                       | 63. P <sub>c</sub> Filter                                |
| 10. Nut  | 26. Union (2)                                       | 44. Washer (4)                                     | 64. Nut  |
| 11. Elbow  | 27. Fuel Control-to-Pump Bypass P <sub>o</sub> Tube | 45. Nut (2)  | 65. Bolt   |
| 12. Fuel Control-to-Governor P <sub>y</sub> Tube | 28. Fuel Pump-to-Control Inlet P <sub>1</sub> Tube  | 46. Nut (2)  | 66. Washer   |
| 13. Gasket                                       | 29. Fuel Nozzle                                     | 47. Gas Producer Fuel Control                      | 67. Coordinator Support Aft Bracket (old configuration)  |
| 14. Propeller Overspeed Governor                 | 30. Fire Shield-to-Fuel Nozzle Hose                 | 48. Washer (3)                                     | 67A. Coordinator Support Aft Bracket (new configuration) |
| 15. Washer (3)                                   | 31. Bolt  | 49. Nut (3)  | 68. Union  |
| 16. Nut (3)                                      | 32. Washer  | 50. O-ring   | 69. Check Valve  |
|  | 33. Nut   | 51. Union  | 70. Washer (2)   |
|  | 34. Coordinator Support Bracket                     | 52. O-ring (2)                                     | 71. Nut  |
|  |   | 53. Union (2)                                      |  |
|  |   | 54. P <sub>c</sub> Filter-to-Fuel Control Air Tube |  |

Figure 3-3. Control System Components



----- CAUTION -----

*When there is evidence that the fuel pump filter has been bypassed the gas producer fuel control filter assembly must be cleaned. (Refer to Cleaning the Gas Producer Fuel Control Fuel Filter, para 3-83.)*

b. Gas Producer Fuel Control Filter. The filter element in the fuel control is cleanable and has a rating of 45 micron. The filter shall be inspected for contamination and cleaned if required any time a fuel pump filter bypass is known or suspected to have taken place. (Refer to Cleaning the Gas Producer Fuel Control Fuel Filter, para 3-83.)

c. Fuel Control P<sub>c</sub> Filter. The fuel control P<sub>c</sub> filter shall be removed and cleaned when dictated by engine performance. (Refer to Fuel Control Cleaning, para 3-91.)

d. Engine P<sub>c</sub> Filter. The P<sub>c</sub> filter shall be removed and cleaned when dictated by engine performance. (Refer to Troubleshooting, Table III-5 and to P<sub>c</sub> Filter, para 3-76.)

**3-73. Fuel Nozzle.** Remove, inspect and clean the spray tips of the fuel nozzle. (See figure 3-3.)

3-74. Remove the fuel nozzle as follows:

- a. Disconnect the fuel nozzle line.
- b. Remove lockwire; then using 23002215 wrench, unscrew the nozzle.
- c. Carefully remove nozzle assembly.

----- CAUTION -----

*Particular care must be taken during removal not to damage the nozzle spray tips.*

3-75. Inspect and clean the fuel nozzle as follows:

a. Check for damage or carbon deposits on spray tips. Figure 3-4 shows the condition of a typical fuel nozzle removed from an operational engine. A nozzle in this condition should be cleaned, if possible, before being reinstalled.

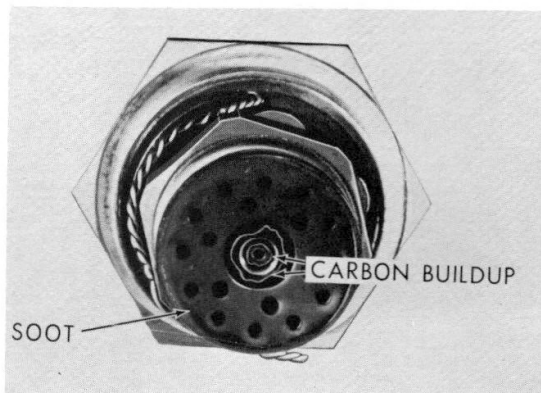
b. Suspend the fuel nozzle vertically with the tip immersed approximately 1/8 in. (3.2mm) in cleaning solvent (Brulin Safety Solvent No. 512 M or Equivalent). Soak the tip for one hour or longer if deemed necessary to remove all carbon. After carbon removal, flush the nozzle internally and externally using Stoddard solvent or kerosene. Dry with a soft cloth.

----- CAUTION -----

*Use extreme care not to damage the mirror finish and edges of the spray tips.*

c. Any damage to the nozzle spray tips is cause for replacement of the fuel nozzle assembly.

d. Reject nozzles exceeding 0.005 in. (0.127mm) max wear on OD of the air shroud.



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**Figure 3-4. Carbon Buildup on Fuel Nozzle**

e. Clean the face of the air shroud with a clean dry cloth; the air holes must be open. Be careful that loosened carbon does not enter the spray tips.

f. Install the fuel nozzle. Tighten nozzle to 200-300 lb in. (23-34 N·m) using 23002215 wrench. Lockwire to the spark igniter.

g. Install fuel hose. Tighten coupling nut to 80-120 lb in. (9.0-13.6 N·m).

h. Check run the engine after fuel nozzle replacement. (Refer to Check Run, para 3-174.)

**3-76. P<sub>c</sub> Filter.** Remove, clean, and reinstall the gearbox bracket mounted P<sub>c</sub> filter as follows. (See figure 3-3.)

a. Disconnect the air tubes from both ends of the filter. Hold the filter while loosening the coupling nuts.

b. Remove the nut and bolt securing the filter clamp to filter mounting bracket. Remove the filter and separate the clamp from the filter.

c. Remove the lockwire and separate the filter element and O-ring from the filter housing. When a vise is used in the disassembly, place the element hex (1, figure 3-5) in the vise and use the wrench on the hex of the housing (3).

d. Clean the filter assembly ultrasonically if equipment is available. If ultrasonic equipment is not available, clean the filter as follows:

(1) Cap the outlet fitting of the filter element with a clean metal cap (AN 820-4 or equivalent).

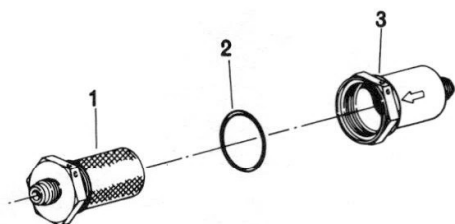
(2) Wash the filter assembly with solvent and a soft bristle brush.

(3) Dry the filter element with the metal cap removed.

Use low pressure air directed from the outside to the inside of the element.

----- CAUTION -----

*Do not use a cloth to dry the filter element.*



- 1. Filter Element
  - 2. O-ring
  - 3. Filter Housing
- 8783A

**Figure 3-5. P<sub>c</sub> Filter Assembly**

e. As an alternate method, clean the P<sub>c</sub> filter element as follows:

- (1) Soak the filter for 20 minutes in sodium hydroxide at 190°F (standard chemical compound).
- (2) Rinse thoroughly in cold running water.
- (3) Dry using clean compressed air.
- (4) Immerse in a neutralizing solution of phosphoric acid (50% acid, 50% water) for five minutes at 70°F.
- (5) Rinse thoroughly in cold running water.
- (6) Dry using clean compressed air.

f. Inspect the filter assembly for dirt or damage. Replace unserviceable filters.

g. Apply high temperature lubricant (Never-Seez, or equivalent) lightly to the threads; then, assemble the O-ring and housing over the filter element. Tighten to 60-65 lb ft and secure with lockwire.

h. Assemble the clamp on the filter and secure it to the filter mounting bracket with a bolt and nut. Tighten the nut to 35-40 lb in. Check to ensure that the arrow on the filter is pointing rearward.

i. Attach the air tubes at both ends of the filter. Hold the filter while tightening the coupling nuts to 80-120 lb in.

**3-77. Fuel Pump and Filter Assembly.** (See figure 3-6.) Replace the filter element in the pump when a filter bypass has been detected or suspected (or every 300 hours on configurations without a bypass warning system). Replace the complete pump assembly if the pump is found to be the cause of engine malfunction.

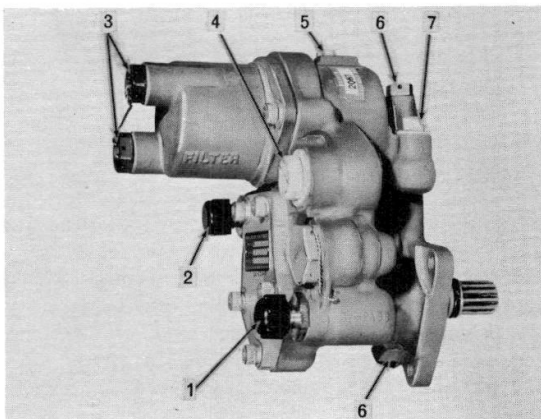
**3-78.** Replace the fuel pump filter element as follows: (See figure 3-7.)

----- **NOTE** -----

*This is a throw-away filter element and is not to be cleaned and reused.*

-----

a. Place a container under the pump assembly as some fuel spillage is likely. Remove the two drain plugs from the filter cover.



- 1. Control Bypass Return Port
- 2. Pump Discharge Port
- 3. Filter Cover Drain Port
- 4. Fuel Inlet Supply Port
- 5. Before Filter Pressure Drop Port
- 6. Seal Drain Port (2)
- 7. After Filter Pressure Drop Port

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**Figure 3-6. Fuel Pump and Filter Assembly**

b. Remove the two screws and washers retaining the cover to the housing.

c. Remove the cover and the element. Discard two O-rings and the contaminated filter element. If the element is a tight fit, remove by pulling straight out. Twisting may cause the element end cap to tear off.

d. Clean the filter cap with a spray of mineral spirits or with a fuel-soaked cloth.

e. Be sure the element O-ring is in place then install the element in the housing. Install the cover with new O-ring. Tighten cover screws to 95-105 lb in.

f. Bleed entrapped air from the fuel system by loosening the upper bleeder plug (figure 3-3) and pressurizing the fuel system with the aircraft boost pump. Turn off the boost pump when a solid stream of fuel is noted coming from the upper bleeder port. Retighten the plug to 40-65 lb in. (4.7-7.6 N-m) and secure with lockwire.

**3-79.** Replace the fuel pump and filter assembly as follows: (See figure 3-3.)

a. Remove the fuel inlet and outlet lines, control bypass lines, and the fuel pump and filter assembly seal drain line at the fuel pump.

b. Remove the three self-locking nuts and washers which secure the fuel pump to the power and accessories gearbox housing. Remove pump from mounting studs.

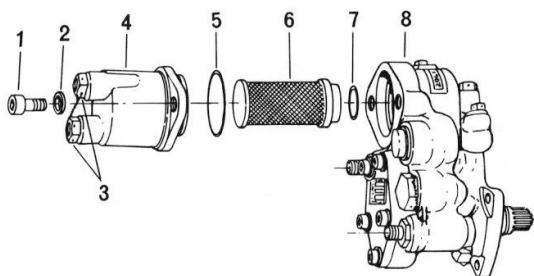
c. Remove the mounting flange gasket.

**3-80.** Install the fuel pump and filter assembly on the engine as follows:

a. Install a new fuel pump drive O-ring seal.

b. Install gasket on mounting pad.

c. Coat pump drive splines and the O-ring with engine oil. Coat the fuel fitting with MIL-L-6081, grade 1010 oil (Atlantic Refining Co. 31100, or equivalent).



- |                 |                   |
|-----------------|-------------------|
| 1. Screw (2)    | 5. O-ring         |
| 2. Washer (2)   | 6. Filter Element |
| 3. Plugs (2)    | 7. O-ring         |
| 4. Filter Cover | 8. Fuel Pump      |

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**Figure 3-7. Fuel Filter Replacement**

d. Install pump on mounting studs. Install three washers and self-locking nuts.

e. Tighten mount pad nuts to 70-85 lb in. (7.91-9.60 N-m). Tighten fuel line coupling nuts to 150-200 lb in. (16.95-22.60 N-m).

f. After the fuel pump has been replaced, bleed the air from the fuel system. (Refer to Purging the Fuel System, para 3-70.)

g. Make appropriate entry relative to pump replacement in the Engine Log.

h. Check run the engine after fuel pump replacement. (Refer to Check Run, para 3-174.)

----- **NOTE** -----

*After the fuel pump has been replaced, if a false start or a start that is not completed in a total time of one minute is encountered, return the condition lever to FUEL OFF-FEATHER and motor the engine without ignition for 10 seconds.*

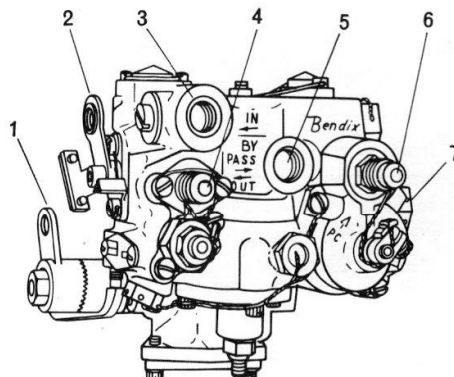
**3-80A. Single Element Fuel Pump Drive Shaft Inspection.**

Perform the 750-hour inspection of the shouldered drive shaft of Sundstrand fuel pumps as follows:

----- **NOTE** -----

*This inspection is not required for TRW pumps.*

a. Remove the fuel pump from the engine. (Refer to removal paragraph 3-79.)



- |   |                                       |
|---|---------------------------------------|
| 1. Throttle Lever                       | 5. Control Bypass (P <sub>O</sub> )   |
| 2. Fuel Cutoff Lever                    | 6. Sensing Pressure (P <sub>S</sub> ) |
| 3. Control Inlet Fuel (P <sub>1</sub> ) | 7. Overspeed Bleed (P <sub>Y</sub> )  |
| 4. Metered Fuel Flow (P <sub>2</sub> )  |                                       |

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**Figure 3-8. Gas Producer Fuel Control**

b. Remove the shouldered drive shaft from the pump. The drive shaft is held in the pump by a retaining ring within the drive gear bore. (See figure 1-4.) pull carefully and evenly on the shaft to free it from the retaining ring and gear.

----- **NOTE** -----

*It is not necessary to remove the retaining ring; however, if the retaining ring should pull out of the groove in the drive gear, the same ring may be reinstalled if it is not damaged. If the retaining ring is damaged, install new ring P/N 99-4660 in the drive gear.*

c. Inspect the spline for wear. If the wear is greater than 0.004 in. (0.102mm) or deep enough to catch a sharp object or a finger nail as it is run across the surface, send the pump to overhaul for replacement of the drive shaft and mating gear.

d. Install the shouldered drive shaft in the pump as follows:

(1) Clean the drive gear bore with mineral spirits. Dry thoroughly after cleaning.

(2) Ensure that the retaining ring is properly seated in the drive gear groove.

(3) Pack the drive gear bore half full of grease. Sundstrand P/N 688272-1 or 688272-2 grease is recommended. If the recommended grease is not available, use Plastilube No. 3 grease.



e. Insert the shouldered shaft into the drive gear until it contacts the retaining ring. Carefully push the shaft approximately 0.5 in. (13 mm) further to where the retaining ring seats in the shaft groove.

----- **CAUTION** -----

*If the shouldered shaft groove is forced past the retaining ring, oil will leak through the engine-to-fuel pump drive splines and drain from the pump. The O-ring on the pump drive spline is properly positioned in the engine gearshaft ID only when the retaining ring seats in the shouldered shaft groove.*

f. Install the pump on the engine. (Refer to installation paragraph 3-80.)

g. Make appropriate entry relative to pump drive shaft inspection in the Engine Log.

h. Check run the engine. (Refer to Check Run, para 3-174).

**3-81. Gas Producer Fuel Control.** (See figure 3-8.)

The gas producer fuel control can be adjusted, the control fuel filter can be cleaned or the control assembly can be replaced as dictated by the engine trouble condition encountered.

----- **NOTE** -----

*Refer to Gas Producer Fuel Control Operational Checks (para 3-87) for a ready method of ground checking the control system and associated linkage.*

3-82. Adjustments. The adjustments that can be made on the fuel control are idle speed, maximum speed and start derichment. Also, on 6899263 (Bendix 2524654-9) or later fuel controls, there is a start/acceleration fuel flow schedule adjustment and a wide range start derichment adjustment.

3-82A. Idle Setting. (Refer to Gas Producer Fuel Control Operational Checks, para 3-87.)

3-82B. Maximum Speed Stop. (See figure 3-9) Adjust screw clockwise to increase or counterclockwise to decrease  $N_1$  speed. One turn equals approximately 1% speed.

----- **CAUTION** -----

*Do not adjust maximum speed stop if 793°C (250-B17) or 810°C (250-B17B) TOT can be reached. Do not exceed 104%  $N_1$ .*

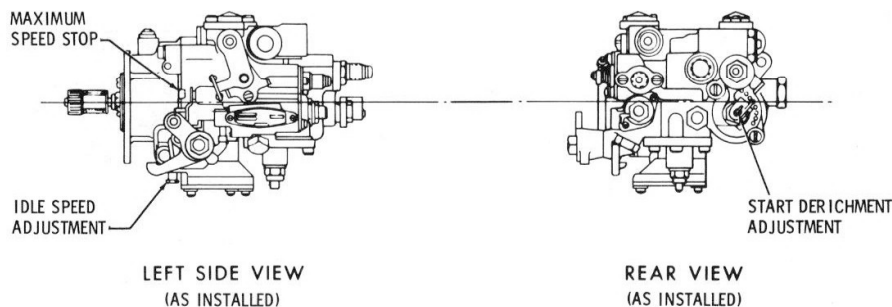
3-82C. Start-Derichment Adjustment. (See figure 3-9 or 3-9A.) The start-derichment (derich) adjustment can be used to correct lean (slow) start or rich (hot) start conditions. This adjustment is effective below 30%  $N_1$  speed. For slow starts at  $N_1$  speeds between 35 and 50%  $N_1$  speed, refer to Start/Acceleration Fuel Flow Adjustment, para 3-82D.

a. For lean starts, adjust the start-derich as follows:

(1) Remove the lockwire securing the adjustment locknut to the  $P_c$  filter-fitting.

----- **CAUTION** -----

*Do not disturb the pointer-to-shaft sealed wire at any time. This is an overhaul function only.*



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**Figure 3-9. Gas Producer Fuel Control Adjustments**



- (2) Loosen the adjustment locknut.
- (3) Make the adjustment using an Allen wrench.

Turn clockwise to enrich the starting fuel flow to improve stagnated starts, cold weather starts, or high altitude ground starts. Make the adjustment in 15° maximum increments (dots are 10° apart) and tighten the locknut to 20-25 lb in. (2.3-2.8 N·m) after each setting. Check the starting peak TOT after each setting until satisfactory starts are made.

- (4) When the desired adjustment is obtained, secure the locknut to the P<sub>c</sub> filter-fitting with lockwire.

----- **CAUTION** -----

*Monitor TOT closely after start-derichment adjustment to be sure overtemperature limits are not exceeded. Record overtemperature in the Engine Log.*

-----

- (5) On fuel controls prior to P/N 6899263 (Bendix P/L 2524654-9), if satisfactory starts are not obtained during steps (1) through (4), proceed as follows:

----- **NOTE** -----

*Make further adjustment to 6899263 (Bendix 2524654-9), or later, fuel controls in accordance with Start/Acceleration Fuel Flow Adjustment, para 3-82D.*

-----

- (a) Return the start-derich pointer to the neutral position. Tighten locknut.
- (b) Install a short No. 10-32 screw into the vent fitting on the start-derich cover. This deactivates the start-derich assembly and allows the operator to check the basic fuel schedule of the control.

----- **CAUTION** -----

*During the attempted start, TOT must be closely monitored to prevent overtemperature operation. Record overtemperature in the Engine Log.*

-----

- (c) Enrich the basic schedule slightly by retightening the start-derich cover screws. Remove lockwire from the screws; then check screw retention torque. Torque should be 9-10 lb in. (1.02-1.13 N·m). Retighten the screws in 2 lb in. (0.23 N·m) increments to a maximum value of 14 lb in. (1.69 N·m). After each 2 lb in. (0.23 N·m) retightening operation, make a start attempt. It is not necessary to remove the No. 10-32 screw from the vent at this time; this is only a check of the integrity of the basic schedule. If satisfactory starts are obtained, lockwire the

derich assembly cover screws and remove the No. 10-32 screw from the vent fitting. Make another start. It may be necessary to adjust the start-derich assembly from the neutral position. After final adjustments have been made, lockwire the start-derich assembly.

- (6) On fuel controls prior to P/N 6899263 (Bendix P/L 2524654-9), if satisfactory starts are not obtained during steps (1) through (5) proceed as follows:

- (a) Return the pointer to the neutral position.
- (b) Disconnect the fuel control-to-inline check valve tube. Provide a means of directing fuel that will be discharged from this port on the control into a clean container.
- (c) Deactivate primary power to the ignition system.

- (d) Motor the engine to approximately 15% N<sub>1</sub> speed; then open the throttle to the 30° (Ground Idle) position. Motor the engine for 15 seconds; then close the throttle.

----- **NOTE** -----

*This procedure is based upon a 15 second fuel flow. Be sure the throttle is closed exactly 15 seconds after it is opened.*

-----

- (e) Using a calibrated beaker, measure the quantity of fuel in the container. There should be 85-95 cc of fuel in the beaker at sea level. At higher altitudes the flow will be less.

----- **NOTE** -----

*For improved accuracy, take the average of three readings.*

-----

- (f) Enrich the basic schedule by adding one shim under the metering valve sleeve retainer. (See figure 3-9B.) Select the shim to give the desired fuel flow schedule. The approximate fuel flow gain for each shim thickness is as follows:

<u>Shim Thickness,</u> <u>in. (mm)</u>	<u>Fuel Flow</u> <u>Gain, cc</u>	<u>Temp. Increase,</u> <u>°F (C°)</u>
0.001 (0.025)	9	194 (90)
0.0015 (0.0381)	14	284 (140)
0.002 (0.051)	18	356 (180)
0.003 (0.076)	24	464 (240)

----- **NOTE** -----

*Only one size shim may be used. Maximum shim thickness must not exceed 0.003 in. (0.076 mm).*

-----

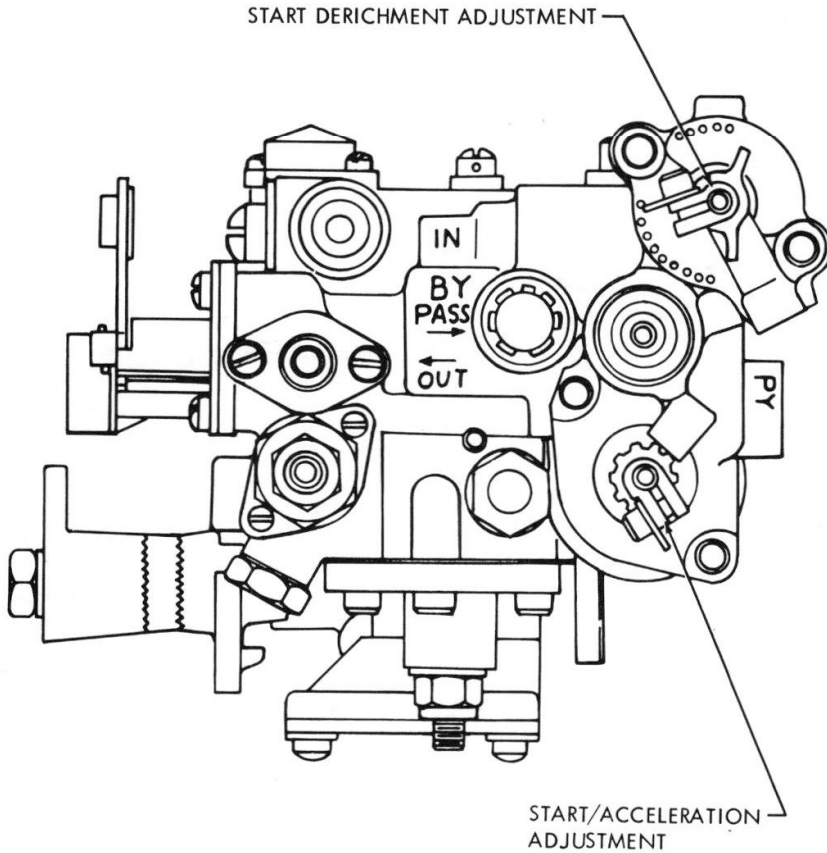


Figure 3-9A. Start/Acceleration and Start-Derichment Adjustments

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(g) Cut out the selected size shim using the template shown in figure 3-9B. Clean up all burrs.

----- **NOTE** -----

*A kit (Bendix P/N 350934) containing one each of the 0.001, 0.0015, 0.002 and 0.003 in. (0.025, 0.0381, 0.051 and 0.076 mm) shims is available through Bendix Supply Centers.*

(h) Remove lockwire and loosen screws securing the metering valve sleeve retainer. Loosen screws enough to allow insertion of the shim under the retainer. Insert selected shim and tighten screws to 9-10 lb in. (1.03-1.13 N-m).

(i) Recheck the fuel flow setting as was accomplished in steps (a) through (e).

(j) If the desired fuel flow is obtained, reinstall the fuel control-to-inline check valve tube. Tighten coupling nuts to 80-120 lb in. (9.04-13.56 N-m).

(k) Start the engine. If satisfactory starts are obtained, lockwire the screws on the metering valve sleeve retainer. It may be necessary to adjust the start-derich assembly from the neutral position. After final adjustments have been made, lockwire the start-derich assembly.

----- **CAUTION** -----

*During an attempt start, TOT must be closely monitored to prevent overtemperature operation. Record overtemperature in the Engine Log.*

b. Rich (hot) starts may be caused by delayed ignition, or premature opening of the throttle. However, hot starts due to high fuel flow are normally caused by the fuel control. When the fuel control is suspected, make an adjustment of the start-derich setting as follows:

(1) Remove lockwire and loosen the adjustment locknut. (See figure 3-9A.)

(2) Make the adjustment using an Allen wrench. Turn counterclockwise (ccw) to lean-out the fuel flow. Make the adjustment in 15° maximum decrements (dots are 10° apart) and tighten the locknut after each setting. Check the starting peak TOT after each setting until satisfactory starts are made.

(3) When the desired adjustment is obtained, secure the locknut to the P<sub>c</sub> filter-fitting with lockwire.

(4) On fuel controls prior to P/N 6899263 (Bendix P/L 2524654-9), if satisfactory starts are not obtained during steps (1) through (3), return the pointer to the neutral position and proceed as follows:

(a) Inspect to determine that there is no obstruction in the vent hole in the start-derich cover.

(b) If visual inspection reveals no discrepancies in the start-derich assembly, troubleshoot the start-derich assembly by checking for air leakage at the vent while attempting a start. No leakage indicates improper functioning of the start-derich assembly.

----- **CAUTION** -----

*During the attempted start, TOT must be closely monitored to prevent overtemperature operation. Record overtemperature in the Engine Log.*

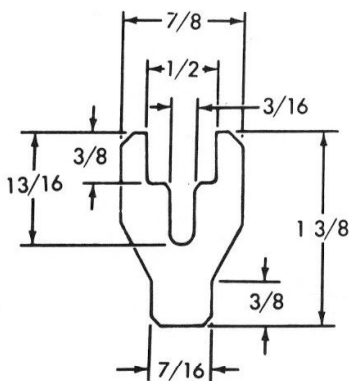
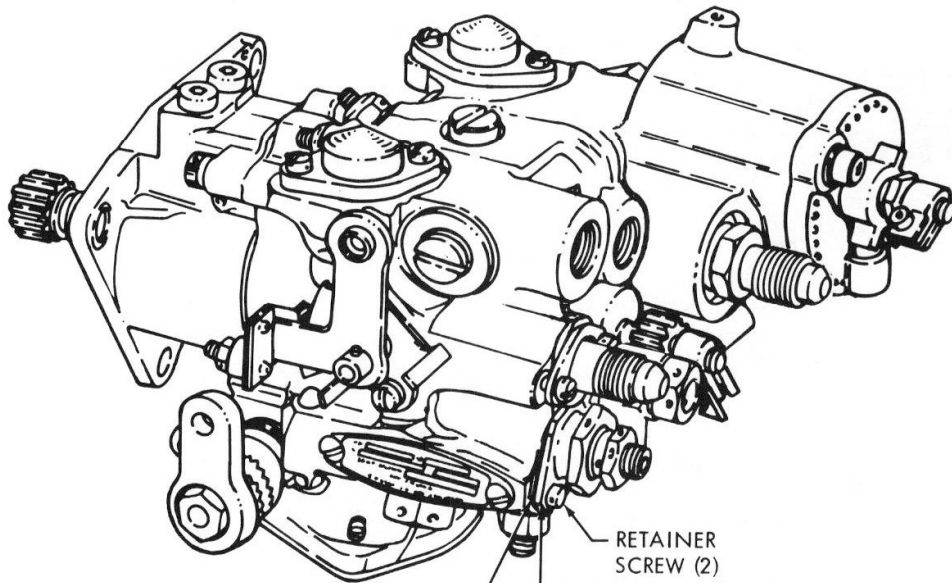
(c) Check the basic fuel schedule by monitoring the first TOT indication. TOT should not exceed 1580°F (860°C). If TOT is between 1580°F (860°C) and 1700°F (927°C), derich the basic schedule slightly by retightening the start-derich cover screws. Remove the lockwire from the screws; then check the screw retention torque. Torque should be 9-10 lb in. (1.02-1.13 N-m). Retighten the screws to the minimum value of 9 lb in. (1.02 N-m). Attempt another start. TOT must not exceed 1580°F (860°C). If satisfactory starts are obtained, lockwire the derich assembly cover screws and the start-derich assembly. If decreasing the cover assembly screw torque does not bring start TOT down to the 1580°F (860°C) limit, the fuel control must be removed and recalibrated.

3-82D. Start/Acceleration Fuel Flow Adjustment (Applicable to 6899263, Bendix 2524654-9, or later fuel controls). The start/acceleration fuel flow schedule adjustment maintains the gas producer fuel control starting schedule within acceptable limits during normal service life. To optimize engine starting, the start-derichment (derich) adjustment should be made in conjunction with the start/acceleration adjustment. (See figure 3-9A.)

----- **NOTE** -----

*The start-derich adjustment on the 6899263 (or later) fuel control has a wider range than earlier models (200 degrees in place of 100 degrees). The effective start-derich speed range is between lightoff and 30% N<sub>1</sub>. Also, turning the adjustment to the cw stop closes the P<sub>y</sub> vent orifice, eliminating the need for inserting a No. 10-32 screw in the vent port.*





**SHIM TEMPLATE**

1. USE ONLY ONE SHIM SIZE.
2. SHIM THICKNESS SHALL NOT EXCEED 0.003 IN. (0.076 MM).
3. CHAMFER CORNERS AND REMOVE BURRS BEFORE USING.

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Figure 3-9B. Metering Valve Sleeve Retainer



3-82E. The following practices and precautions should be observed when making the start/acceleration fuel flow adjustment:

----- **NOTE** -----  
*To accurately determine the proper adjustment, conditions under which the adjustments are made should be consistent, i.e., a fully charged aircraft battery, the same residual TOT and the same lightoff speed.*  
-----

- a. There are eight positions for the adjuster. Detent grooves hold the adjuster in the selected one of these positions without the need of a jam nut or lockwire.
- b. Check idle speed and deceleration time after the final start setting is determined. (Refer to Idle Speed Setting, para 3-90.)

----- **CAUTION** -----  
*Make adjustments in changes of one detent (click) at a time. Adjustments of more than one detent at a time can cause turbine overtemperature (cw adjustment) or a decrease in starting time to a possible hung start (ccw adjustment).*  
*Do not use the start/acceleration adjustment to correct for normal maintenance items such as mis-rigging, air leaks, fuel leaks, ignition problems, starter-generator system problems etc.*  
*Do not use the start/acceleration adjustment exclusively to improve engine starting. Excessive cw settings before encountering over-temperature results in a single high peak TOT over a wide speed range for a large part of the starting time. Use the start-derich adjustment with the start/acceleration adjustment to optimize engine starting.*  
-----

3-83. Cleaning the Gas Producer Fuel Control Fuel Filter. Remove, clean and reinstall the fuel control fuel filter assembly as follows: (See figure 3-10.)

- a. Remove lockwire from the plug.

----- **NOTE** -----  
*Thoroughly clean the exterior of the fuel control in the area of the plug to prevent contaminants from getting into the port after it is opened.*  
-----

- b. Remove the plug, spring and the filter assembly from the fuel control. Discard O-ring.
- c. Remove the clip and spring pin. Separate the washer, spring and strainer assembly from the filter sleeve.
- d. Clean the filter assembly parts ultrasonically if equipment is available. If equipment is not available, agitate the parts in mineral spirits. Dry parts using clean shop air regulated to approximately 15 psig. Air pressure should be applied to the exterior of the strainer. Repeat the procedure if visual inspection with a bright light shows that the interior of the strainer is not entirely free of contaminants.

----- **CAUTION** -----  
*Do not attempt to open a clogged screen with a sharp instrument.*  
-----

- e. The following cleaning procedure may be used as an alternate if the method described in step d. does not clean the strainer assembly satisfactorily.

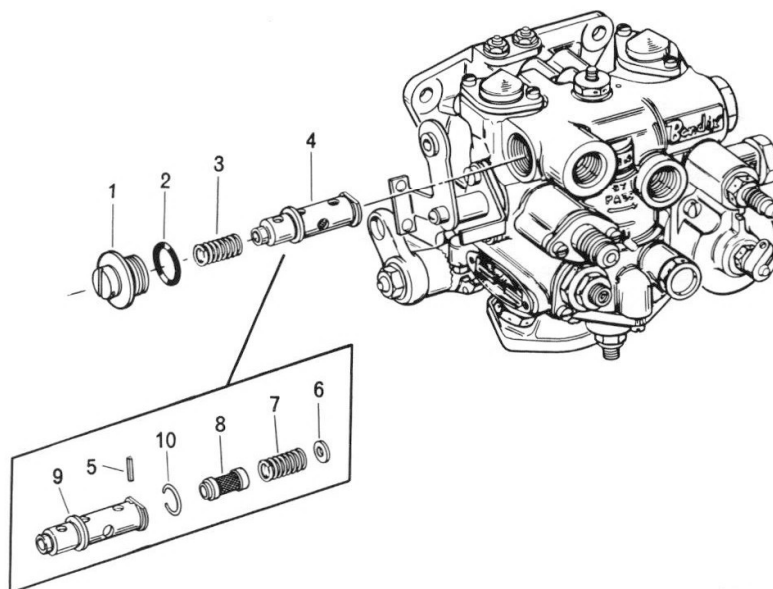
(1) Immerse the strainer assembly in sulphuric acid (specific gravity 1.82 to 1.84) containing approximately 20 grams of sodium dichromate per liter (0.2642 U.S. gallon) for a period of two to five minutes at room temperature.

----- **WARNING** -----  
*Sulphuric acid causes severe burns. Do not get in eyes, on skin or on clothing. Do not add water to acid while in a container because of violent reaction. In the event of contact with sulphuric acid, immediately flood exposed skin or clothing with water. For eyes, flush heavily with water and obtain immediate medical attention.*  
-----

- (2) Rinse in hot running water and dry with a hot air blast.

- f. Reassemble the strainer, spring, and washer in the filter sleeve. Secure the components in the sleeve with the spring pin and clip.

----- **CAUTION** -----  
*Be sure the strainer assembly is installed as shown in figure 3-10 with the open end toward the outside of the control, away from the spring. Do not install backwards.*  
-----



8877X

- |                    |                      |
|--------------------|----------------------|
| 1. Plug            | 6. Washer            |
| 2. O-ring          | 7. Spring            |
| 3. Spring          | 8. Strainer Assembly |
| 4. Filter Assembly | 9. Filter Sleeve     |
| 5. Spring Pin      | 10. Clip             |

**Figure 3-10. Fuel Control Fuel Filter Removal**

g. Lightly lubricate a new O-ring (Bendix P/N 557S6) with engine fuel and place it on the plug. Install the filter assembly, spring and the plug in the fuel control. Tighten plug to 65-70 lb in. and secure with lockwire.

**NOTE**

*If the old O-ring must be reused, dry it under a heat lamp to restore dimensions.*

3-84. Gas Producer Fuel Control Replacement. Replace the fuel control assembly if it is found to be the cause of engine malfunction.

**CAUTION**

*Use extreme care to ensure that the pneumatic lines and fittings are not leaking. Erroneous pressures will cause fuel control malfunction.*

3-85. Remove the gas producer fuel control from the engine as follows: (See figure 3-3.)

**CAUTION**

*When the fuel control is being removed, use extreme care to prevent foreign materials from entering the pneumatic lines or fuel control ports.*

- Remove the linkage connections, fuel and air lines. Remove the P<sub>y</sub> line (31, fig. 3-15) from the fuel control and the governor.
- Remove three nuts and washers which secure the control to the power and accessories gearbox housing.
- Carefully remove the control.
- If the unit is to be replaced, remove all fittings necessary for installation of the replacement unit.

**CAUTION**

*When removing or installing fittings be careful not to cause a load on the fuel control drive shaft. Use the wooden protective shipping block to protect the shaft from the work bench.*



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e. Drain residual fuel from the rejected fuel control and fill the inlet and bypass ports with oil (Atlantic Refining Co. 31100, or equivalent). Open the cutoff valve, using the fuel cutoff lever, and fill the outlet port with oil. Cap the inlet, bypass and cutoff ports.

3-86. Install the gas producer fuel control on the engine as follows:

a. Coat fuel control drive shaft with Lubriplate 130A (or equivalent) and studs and fuel fittings with oil (Atlantic Refining Co. 31100, or equivalent). Use the wooden protective shipping block to protect the shaft from the work bench when installing the fittings. Prior to installation of the elbows, thoroughly clean inside the elbows with mineral spirits. Shake then air dry.

b. Install in reverse of removal. Prior to installation, use mineral spirits to thoroughly clean inside the P<sub>y</sub> line. Shake then air dry.

----- CAUTION -----

*Be certain that the control drive pilot is properly inserted in the gearbox.*

c. Tighten mount pad nuts to 70-85 lb in. Tighten fuel line coupling nuts to 150-200 lb inch; tighten control air line coupling nuts to 80-120 lb in.

d. Attach linkage in accordance with Procedures C and D of Coordinator Rigging, para 3-104 and 3-105.

e. Check the fuel control lever travel using the cockpit control. The lever stop arm on the fuel control must bottom out on the maximum speed stop. (Refer to Rigging Check, para 3-89.)

f. After the fuel control has been replaced, bleed the system as follows:

(1) Disconnect the fuel line coupling at the fuel nozzle. Place the end of the line in a suitable container.

(2) Move the condition lever to the maximum (100% propeller speed) position.

(3) Motor the engine without ignition until a solid stream of fuel flows from the disconnected line.

(4) Move the condition lever to the FUEL OFF-FEATHER position.

(5) Attach the fuel line to the fuel nozzle. Tighten coupling nut to 150-200 lb in.

----- NOTE -----

*After the fuel control has been changed, if a false start is encountered or a start is not completed in one minute, return the condition lever to FUEL OFF-FEATHER and motor the engine without ignition for 10 seconds before attempting another start.*

g. Make appropriate entry relative to fuel control replacement in the Engine Log.

h. Check run the engine after fuel control replacement. (Refer to Check Run para 3-174.)

**3-87. Gas Producer Fuel Control Operational Checks.**

3-88. Ground check the control system by making a check of the rigging followed by a check of the idle speed setting.

a. Check rigging. (Refer to Rigging Check, para 3-89.)

b. Check idle speed setting. (Refer to Idle Speed Setting, para 3-90.)

3-89. Rigging Check. Check the rigging of the gas producer fuel control after installation of a fuel control or any component of the rigging system. Make the rigging check with the engine shut down using the following procedure.

a. Check the power lever-to-coordinator relationship. The MAX REVERSE, GROUND IDLE and TAKE-OFF positions on the power lever quadrant must coincide with the 0°, 30° and 95° positions respectively on the coordinator protractor within ±1°.

b. Check to ensure that the power turbine lever on the propeller-power turbine governor assembly and the gas producer lever on the gas producer fuel control are against their maximum speed stops when the power lever is at the TAKEOFF position.

c. Retard the power lever to the position which provides the maximum reset of the gas producer lever. In this position the gas producer lever moves toward the maximum speed stop when the power lever is advanced or retarded. Check to ensure that the lever is approximately  $\frac{3}{16}$  inch from the minimum speed stop.

d. Retard the power lever to the MAX REVERSE position. Check to ensure that the power turbine lever is approximately  $\frac{1}{8}$  inch from the maximum speed stop.

e. Check the condition lever-to-propeller-power turbine governor relationship. With the condition lever at the maximum (100% propeller speed) position, the propeller governor lever on the governor assembly must be against the maximum speed stop.

f. Move the condition lever to the FUEL OFF-FEATHER position. The propeller governor lever must be against the minimum speed stop.



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g. Check to ensure that the fuel cutoff lever on the fuel control is in the cutoff detent.

h. Looseness encountered in the rigging must be minimized by replacement of worn items and/or accuracy of the rigging. Looseness that cannot be removed must be within limits.

----- **NOTE** -----

*Make rigging adjustments on aircraft having dual controls using the pilots controls. Recheck the linkage movement using the copilots control. The limits are applicable to both sets of controls.*

i. If no discrepancies were found in the rigging, proceed with the idle speed check. If discrepancies were found, correct as required then proceed with the idle speed setting check.

3-90. Ground Idle Speed Setting. Check the ground idle speed setting with the engine running. Stabilized idle speed should repeat each time, whether the power lever is moved slowly or snapped to the idle position. Failure to repeat is cause for a recheck of the rigging. Check for proper idle adjustment and rigging as follows:

- a. Turn generator switch off.
- b. Ensure that the condition lever is at the maximum (100% propeller speed) position.
- c. Advance the power lever above FLIGHT IDLE and stabilize for at least 15 seconds.
- d. Retard the power lever to GROUND IDLE and note the stabilized  $N_1$  speed.
- e. Retard the power lever toward MAX REVERSE and stabilize for 15 seconds.
- f. Advance the power lever to GROUND IDLE and note the stabilized  $N_1$  speed. It must be the same (approximately) as the  $N_1$  speed noted in step d.

g. If the idle speed did not repeat, improper rigging adjustment or excessive looseness in the airframe, or engine linkage is indicated. Check the linkage for general condition and looseness. Check the power lever-to-coordinator and coordinator-to-fuel control gas producer lever rigging. (Refer to Rigging Check and Coordinator Rigging—Procedure D, para 3-89 and 3-105.)

h. When repeatability is obtained within 1%, stabilize at GROUND IDLE and check to ensure that  $N_1$  speed is within the range of 59-65%.

i. If adjustment is required, turn the idle speed adjustment clockwise to increase, counterclockwise to decrease  $N_1$  speed using wrench 6798292. (See figure 3-9.) A  $\frac{1}{8}$  turn adjustment changes  $N_1$  speed approximately 5%.

3-91. Fuel Control Cleaning. Clean the  $P_c$  filter and  $P_x$  and  $P_y$  bleeds on fuel controls when acceleration and/or deceleration difficulties are encountered.

3-92. Remove, clean, and reinstall the  $P_c$  filter as follows:

a. If necessary, remove the fuel control from the engine. Immediately cap all open ports.

----- **CAUTION** -----

*Keep the work area clean at all times to ensure that contaminants do not get into the fuel control.*

b. Clean the  $P_c$  filter area of the fuel control with methylethylketone. Blow dry.

c. Remove the  $P_c$  filter. (See figure 3-11.) Carefully remove the three O-rings from the filter. These O-rings are reusable if undamaged.

d. Agitate the  $P_c$  filter in a solution of sulphuric acid or electrolyte that has a specific gravity of approximately 1.175. After removal from the cleaning solution, thoroughly rinse the filter in water to neutralize the acid.

----- **CAUTION** -----

*Use normal precautions when working with sulphuric acid. Cleaning time of the filter when using sulphuric acid of 1.175 specific gravity should not exceed 30 minutes.*

----- **NOTE** -----

*Mineral spirits may be used if sulphuric acid is not available.*

e. Suction clean the  $P_c$  filter chamber in the fuel control. (See figure 3-12.)

f. Remove, clean, and reinstall the  $P_x$  bleed; then, remove, clean, and reinstall the  $P_y$  bleed. Use wrench, Bendix No. T26927, for removing or installing the bleeds. (See figure 3-1.)

----- **CAUTION** -----

*To avoid intermixing the  $P_x$  and  $P_y$  bleeds, do not remove both bleeds at the same time. The  $P_x$  and  $P_y$  bleeds are not interchangeable.*

g. Clean the  $P_x$  or  $P_y$  bleed ultrasonically if equipment is available; if it is not, hold the bleed with instrument tweezers and agitate it in mineral spirits in a clean



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container. Insert a sewing thread through the bleed hole. Slide the bleed back and forth on the thread to remove the film.

----- **CAUTION** -----

*Do not blow the bleed dry. The small bleed can be easily lost or damaged.*

h. Inspect the P<sub>x</sub> or P<sub>y</sub> bleed for cleanliness using a flashlight. Place the bleed on the center of the lens so the light can be seen through the bleed hole. Reclean the bleed if any particles or coating can be seen.

----- **CAUTION** -----

*Do not use a probe to remove particles lodged in the bleed.*

i. Install the cleaned P<sub>x</sub> or P<sub>y</sub> bleed in the fuel control using wrench Bendix No. 726927. Tighten to 9-11 lb in. (1.02-1.24 N-m).

j. Install the P<sub>c</sub> filter in the fuel control. If new O-rings are required use Bendix P/N 953515-4, 951394, and 951395. Sparingly lubricate all O-rings with petroleum. Tighten the fitting to 40-50 lb. in. (4.52-5.65 N-m).

k. Make a record of cleaning the P<sub>c</sub> filter, P<sub>x</sub> and P<sub>y</sub> bleeds in the Engine Log book.

l. Install the fuel control on the engine.

m. Perform the acceleration check as follows.

(1) Make a normal engine start. Stabilize at FLIGHT IDLE.

----- **CAUTION** -----

*Do not exceed torque, temperature, or N<sub>1</sub> speed limits during the acceleration check.*

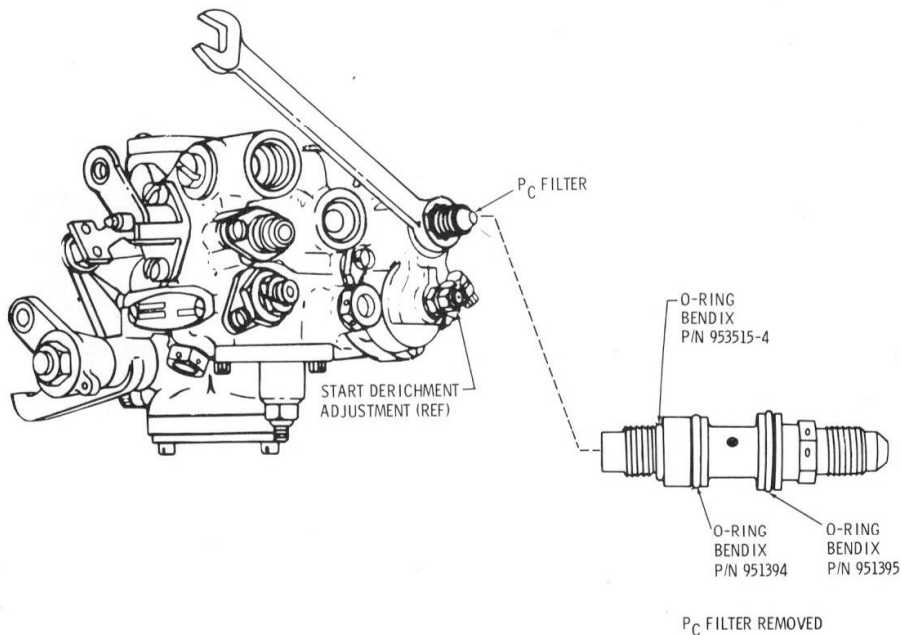
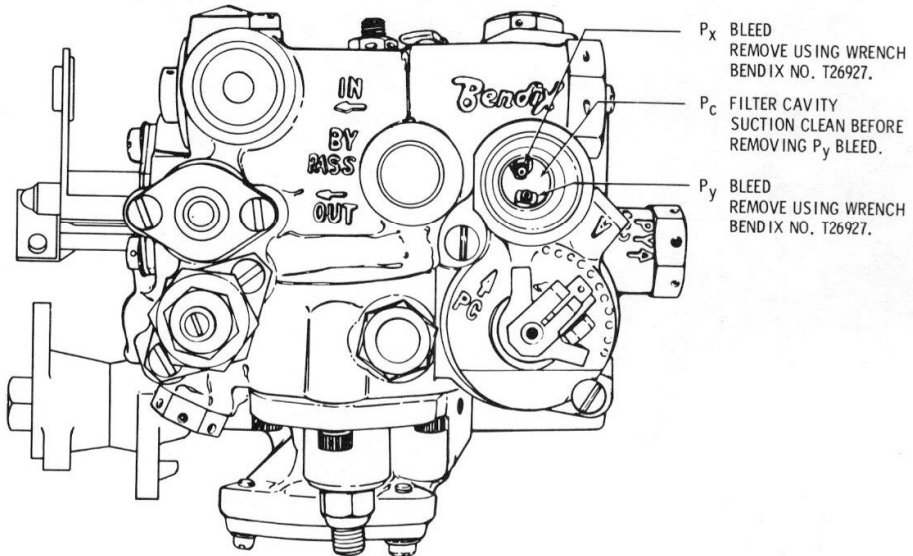


Figure 3-11. Fuel Control P<sub>c</sub> Filter Removal

8876A



**Figure 3-12. Fuel Control P<sub>x</sub> and P<sub>y</sub> Bleeds Removal**

8875A

(2) Using a power lever movement that is quick enough to require the engine to demonstrate normal acceleration capability, advance the power lever to 100% N<sub>2</sub>. Note that N<sub>1</sub> and N<sub>2</sub> acceleration rates are normal.

----- **CAUTION** -----

*Allow for possible aircraft power surge and for asymmetric thrust imbalance (multi-engine configurations only) during the acceleration.*

(3) Repeat the acceleration check three times to ensure repeatability.

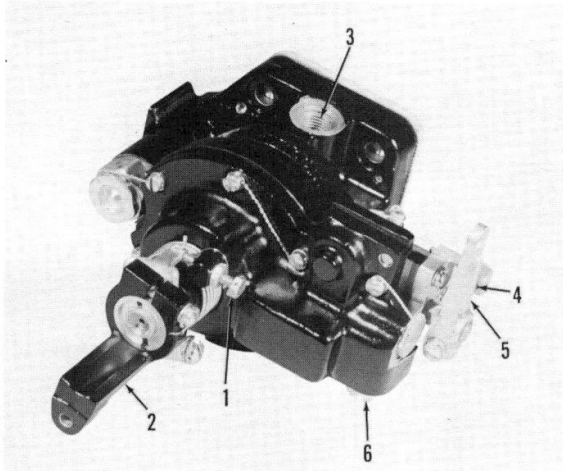
(4) If acceleration is too slow, replace the fuel control.

(5) If acceleration rates are inconsistent, check the rigging. Repeat the acceleration check.

(6) If acceleration is consistent, no further action is required.

**3-93. Propeller-Power Turbine Governor Assembly.**

Replace the propeller-power turbine governor assembly if either governor is found to be the cause of engine malfunction. (See figure 3-13.)



247033

1. Propeller Governor Max Speed Stop
2. Propeller Governor Lever
3. Propeller Control Oil Port
4. Power Turbine Max Speed Stop
5. Power Turbine Lever
6. P<sub>y</sub> Pressure Port

**Figure 3-13. Propeller-Power Turbine Governor Assembly**

3-94. Remove the Propeller-power turbine governor assembly from the engine as follows:

a. Remove attached tube and linkage.

(1) Loosen coupling nut and separate propeller operating (servo) oil line from the governor assembly.

(2) Loosen coupling nuts and remove the P<sub>y</sub> pneumatic tube (31, fig. 3-15) from the elbows of the governor and fuel control.

(3) Remove the power turbine governor and the propeller governor linkage.

b. Remove four nuts and washers and separate the governor assembly from the reduction gearbox.

c. If a new governor assembly is to be installed, proceed as follows:

----- **NOTE** -----

*Use the plastic protective cover to protect the drive shaft from the work bench when removing the fittings.*

(1) Loosen the jam nut and remove the elbow from the P<sub>y</sub> pressure port.

(2) Loosen the jam nut and remove the elbow-filter assembly from the propeller control oil port.

3-95. Install the propeller-power turbine governor assembly on the reduction gearbox as follows:

a. If a new governor assembly is to be installed, proceed as follows:

----- **NOTE** -----

*Use the plastic protective cover to protect the drive shaft from the work bench when installing the fittings.*

(1) Place a new O-ring on the elbow-filter assembly and install in the propeller control oil port. Do not tighten the jam nut.

(2) Thoroughly clean inside the elbow with mineral spirits. Shake then air dry.

(3) Place a new O-ring on the elbow and install in the P<sub>y</sub> pressure port. Do not tighten the jam nut.

b. Coat the drive splines with Lubriplate 130A or equivalent.

c. Rotate the prop governor coupling in the reduction gearbox by hand until the slots of the coupling are fully engaged with the lugs of the prop governor driven bevel gear. When engagement is made the coupling will no longer turn and the coupling will be slightly below the drive pad face.

----- **CAUTION** -----

*If the bevel gear lugs are not fully seated in the coupling slots, installation of the governor will bend the drive lugs.*

d. Position the governor assembly with a new gasket on the drive pad and secure with four washers and nuts. Tighten the nuts to 70-85 lb in. (7.9-9.6 N-m).

----- **CAUTION** -----

*To ensure that proper alignment is achieved between the governor, drive shaft and bevel drive gear at the time of governor installation, hold the governor flush with its mating mounting pad and tighten the top RH nut first. Next install and tighten the lower LH nut. Then install and tighten the remaining two nuts.*

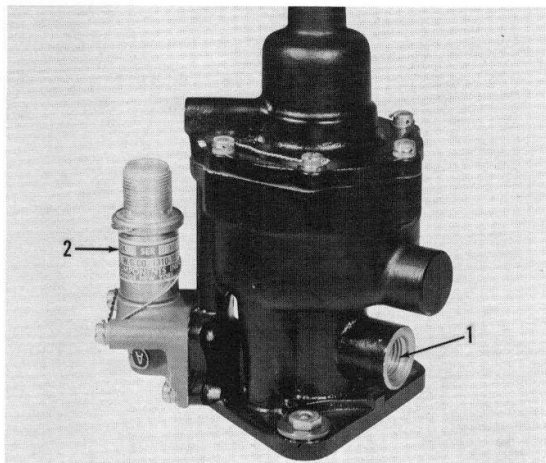
e. Attach the propeller operating (servo) oil tube to the governor assembly. Tighten coupling nut to 80-120 lb in. (9.0-13.6 N-m). Tighten the elbow jam nut to 55-80 lb in. (6.2-9.0 N-m).

f. Thoroughly clean inside the removed P<sub>y</sub> line using mineral spirits. Shake then air dry. Attach the line to the governor and to the fuel control. Tighten the coupling nut to 80-120 lb in. (9.0-13.6 N-m). Tighten the elbow jam nut to 55-80 lb in. (6.2-9.0 N-m).

g. Attach linkage to the power turbine lever and propeller governor lever. (Refer to Procedures A and B of the Coordinator Rigging, para 3-102 and 3-103.)

h. Make appropriate entry relative to governor assembly replacement in the Engine Log.

i. Check run the engine after propeller-power turbine governor replacement. (Refer to Check Run, para 3-174.)



247034

1. Propeller Control Oil Port
2. Propeller Overspeed Checkout Solenoid

**Figure 3-14. Propeller Overspeed Governor**

**3-96. Propeller Overspeed Governor.** Replace the propeller overspeed governor as follows: (See figure 3-14.)

- a. Loosen the coupling nut and separate the propeller positioning (servo) oil tube from the governor.
- b. Remove the lead from the propeller overspeed checkout solenoid.
- c. Remove the three nuts and washers which secure the governor to the power and accessories gearbox. Remove the governor from the mounting studs.

----- **NOTE** -----  
*If a new overspeed governor is to be installed, transfer the fitting from the replaced governor. Use the wooden shipping block to protect the shaft from the work bench.*

**3-97.** Install the propeller overspeed governor as follows.

- a. Coat the drive splines with Lubriplate 130A or equivalent.
- b. Position the governor on the drive pad and secure with three washers and nuts. Tighten nuts to 70-85 lb in. (7.91-9.60 N-m).

----- **CAUTION** -----  
*Be certain the governor drive pilot is properly inserted in the gearbox.*

- c. Attach servo oil tube to the overspeed governor. Tighten coupling nut to 80-120 lb in. (9.04-13.56 N-m).
- d. Make appropriate entry relative to overspeed governor replacement in the Engine Log.
- e. Check run the engine after propeller overspeed governor replacement. (Refer to Check Run, para 3-174.)

**3-98. Coordinator Assembly.** Replace the coordinator assembly as follows: (See figure 3-15.)

- a. Remove the linkage from the following levers on the coordinator. (See figure 3-16.)
  - (1) Input power lever (airframe linkage)
  - (2) Gas producer lever
  - (3) Power turbine governor lever
  - (4) Beta control lever
  - (5) Condition lever (airframe linkage)
  - (6) Inner propeller governor outrigger lever
  - (7) Fuel cutoff outrigger lever
- b. Loosen the coupling nuts on the check valve-to-fire shield pressure oil tube. Disconnect the tube at the fire shield.
- c. Remove the nut, bolt, and washer which secure the coordinator support aft bracket to the engine.
- d. Remove one bolt and washer at each location and separate the coordinator support upper and lower brackets from the coordinator support forward bracket.
- e. Remove the bolt, washer, and nut and separate the coordinator support bracket from the propeller governor control cable LH bracket. Remove the coordinator.
- f. Remove the two nuts that attach the coordinator support aft bracket to the coordinator.

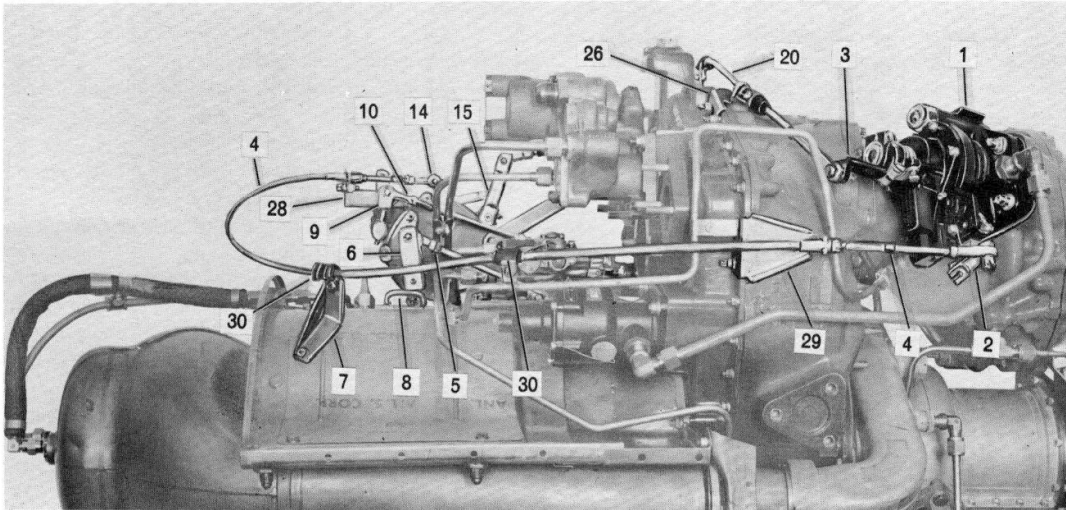
**3-99.** Install the coordinator assembly on the engine as follows:

- a. Install the coordinator support aft bracket on the coordinator and secure with two nuts. Tighten the nuts to 30-40 lb in. (3.39-4.52 N-m).
- b. Place the coordinator and bracket assembly on the engine. Place the washer over the male thread of the pressure oil manifold inlet. Center the holes of the fire shield panel and the coordinator support aft bracket about the manifold inlet. Secure the bracket and the panel at this location with a nut. Tighten nut finger tight. Secure at the forward end of the aft bracket with a bolt and washer. Tighten bolt to 70-85 lb in. (7.91-9.60 N-m). After tightening the bolt, loosen the nut and check that the holes of the aft bracket and the fire shield panel are still centered about the manifold inlet. Adjust as necessary. Tighten nut to 5 lb in. (0.56 N-m) (finger tight) and lockwire to the bolt.
- c. Attach the coordinator support bracket to the propeller governor control cable LH bracket using a bolt, washer, and nut. Tighten nut to 30-40 lb in. (3.39-4.52 N-m).
- d. Attach the coordinator support upper and lower brackets to the coordinator support forward bracket using one bolt and washer at each location. Tighten bolts to 30-40 lb in. (3.39-4.52 N-m).
- e. Connect the check valve-to-fire shield pressure oil tube at the fire shield. Tighten both coupling nuts to 80-120 lb in. (9.04-13.56 N-m).

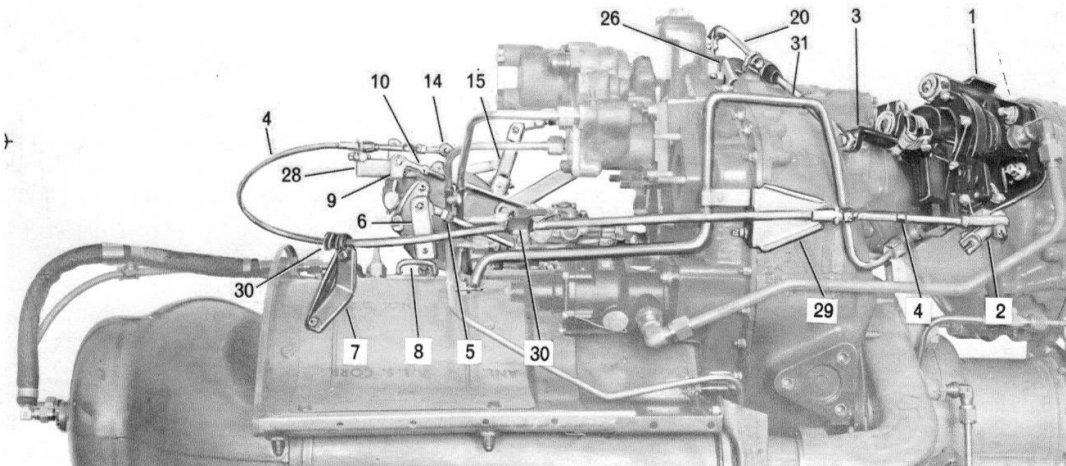


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|--|---|--|
| <ul style="list-style-type: none"> <li>1. Propeller-Power Turbine Governor Assembly</li> <li>2. Power Turbine Lever</li> <li>3. Propeller Governor Lever</li> <li>4. Power Turbine Governor Cable</li> <li>5. Beta Control Tie Rod</li> <li>6. Beta Control Lever</li> <li>7. Power Turbine Cable Aft Support Bracket</li> <li>8. Coordinator Support Aft Bracket</li> <li>9. Fuel Cutoff Outrigger Lever</li> <li>10. Fuel Cutoff Tie Rod</li> <li>11. Condition Lever</li> </ul> | <ul style="list-style-type: none"> <li>12. Coordinator</li> <li>13. Power Lever</li> <li>14. Power Turbine Governor Lever</li> <li>15. Inner Propeller Governor Outrigger Lever</li> <li>16. Gas Producer Control Tie Rod</li> <li>17. Gas Producer Fuel Control</li> <li>18. Control Fuel Cutoff Lever</li> <li>19. Control Gas Producer Lever</li> <li>20. Propeller Governor Control Cable</li> <li>21. Support Lower Bracket</li> <li>22. Support Forward Bracket</li> <li>23. Support Upper Bracket</li> </ul> | <ul style="list-style-type: none"> <li>24. Coordinator Support Bracket</li> <li>25. Propeller Governor Control Cable LH Bracket</li> <li>26. Propeller Governor Control Cable RH Bracket</li> <li>27. Propeller Governor Control Cable Support Strap</li> <li>28. Power Turbine Control Cable LH Support Bracket</li> <li>29. Power Turbine Control Cable RH Bracket</li> <li>30. Clamp</li> <li>31. P<sub>y</sub> Pneumatic Line</li> </ul> |
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Figure 3-15. Coordinator Installation



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f. Attach engine assembly linkage to the following levers on the coordinator assembly: (Refer to Procedures **A**, **B**, **C**, and **D** of Coordinator Rigging, para 3-100. If beta control valve and propeller are on the engine also refer to Propeller and Beta Valve, para 3-107.)

- (1) Gas producer lever
- (2) Power turbine governor lever
- (3) Beta control lever
- (4) Inner propeller governor outrigger lever
- (5) Fuel cutoff outrigger lever

g. Attach airframe linkage to the input power lever and

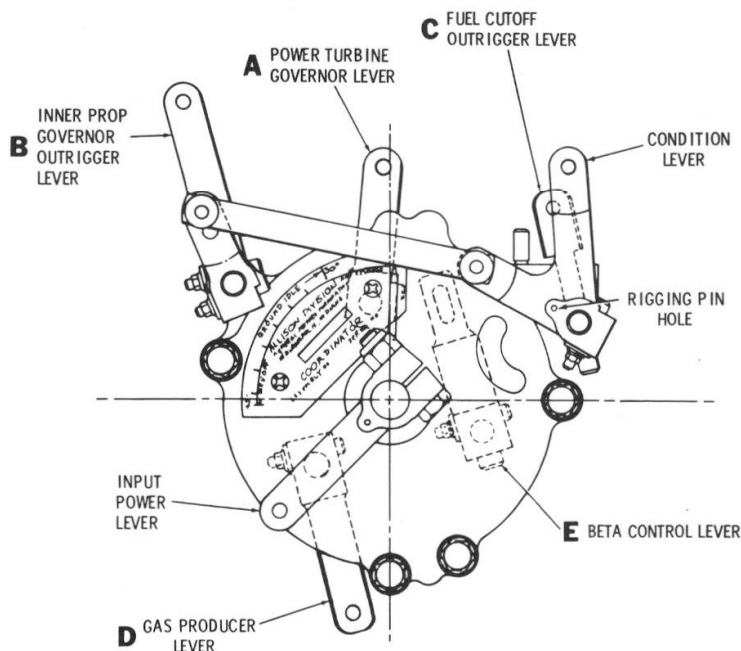
to the condition lever of the coordinator assembly.

### **3-100. COORDINATOR RIGGING.**

3-101. Coordinator rigging is divided into five separate procedures, one for each output lever of the coordinator assembly. (See figures 3-15 and 3-16.)

**3-102. Procedure A—Power Turbine Governor Lever.** The coordinator power turbine governor lever (**A**, figure 3-16.) is connected to the power turbine lever on the propeller-power turbine governor assembly (referred to as governor assembly) as follows:





9139A

Figure 3-16. Coordinator Levers

a. Retain the power turbine governor cable to the engine with supports at the coordinator housing, fire shield, and power and accessories gearbox. Retain the cable to the fuel control-to-governor  $P_y$  air tube with two clamps.

----- NOTE -----

*Always install the cable using the maximum possible bend radii.*

b. Rotate the input power lever on the coordinator counterclockwise until the lever pointer is aligned with the 95° (TAKEOFF) position on the protractor.

c. Ensure that the power turbine lever on the governor assembly is against the maximum speed stop. The lever is spring loaded toward the stop.

d. Attach the power turbine governor cable to coordinator lever **A** with a bolt and nut. Tighten nut to 10-35 lb in. (1.13-3.95 N-m) and secure with a cotter key.

e. Adjust cable length (rotate rod end) until the hole in the rod end and governor assembly power turbine lever align. Make this cable adjustment with the power turbine lever loaded against the maximum speed stop. Take up

cable looseness by compression. Attach the cable to the lever with a bolt, washer, and nut. Tighten nut to 10-35 lb in. and secure with a cotter key.

f. Ensure that the threaded ends of the cable extend into the rod ends past the inspection hole to assure adequate thread engagement; then lockwire the jam nuts.

g. Rotate the coordinator input power lever fully clockwise. The lever pointer should be aligned with the 0° (MAX REVERSE) position on the protractor.

h. Check the position of the governor assembly power turbine lever; the lever should be about 1/8 inch (3.18 mm) from the maximum speed stop.

i. Return the coordinator input power lever to the 95° position. Check that the governor assembly power turbine lever is again at the maximum speed stop position.

j. Rotate the coordinator input power lever and check for freedom of movement. The lever shall move freely without evidence of binding.

**3-103. Procedure B—Inner Propeller Governor Outrigger Lever.** The coordinator inner propeller governor outrigger lever (**B**, figure 3-16) is connected to the propeller governor lever on the propeller-power turbine governor assembly (referred to as governor assembly) as follows:



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a. Retain the propeller governor control cable to the power and accessories gearbox with supports at three locations.

----- NOTE -----

*Always install the cable using the maximum possible bend radii.*

b. Position the condition lever on the coordinator to align the rigging pin holes. Insert rigging pin 6872575.

c. Attach the propeller governor control cable to the inner propeller governor outrigger lever (B, figure 3-16) on the coordinator with a bolt and nut. Tighten nut to 10-35 lb in. and secure with a cotter key.

d. Rotate the propeller governor lever on the governor assembly counterclockwise against the minimum speed stop; the lever is spring loaded in the clockwise direction. Adjust the cable length at the governor assembly end in a manner to load the propeller governor lever against the minimum speed stop. Take up cable looseness by compression of the cable. Attach the cable to the propeller governor lever with a bolt, washer, and nut. Tighten nut to 10-35 lb in. and secure with cotter key.

e. Ensure that the threaded ends of the cable extend into the rod ends past the inspection hole to assure adequate thread engagement; then lockwire the jam nuts.

f. Remove the rigging pin and move the condition lever rearward (clockwise) until the propeller governor lever contacts the maximum speed stop. The condition lever should move freely without evidence of cable binding.

g. Move the condition lever forward (counterclockwise) until the propeller governor lever contacts the minimum speed stop. There should be no evidence of cable binding. The rigging pin should insert freely.

**3-104. Procedure C—Fuel Cutoff Outrigger Lever.** The coordinator fuel cutoff outrigger lever (C, figure 3-16) is connected to the gas producer fuel control fuel cutoff lever as follows:

a. Position the condition lever on the coordinator to align the rigging pin holes. Insert rigging pin 6872575.

b. Rotate the fuel cutoff lever on the fuel control in a counterclockwise direction until the lever engages the fuel cutoff detent (labeled C.O.) on the detent plate.

c. Adjust fuel cutoff tie rod until holes in the rod ends align (approximately) with holes in the coordinator fuel cutoff outrigger lever and the fuel control fuel cutoff lever.

d. Attach fuel cutoff tie rod to the coordinator fuel cutoff outrigger lever with a bolt and nut. Tighten the nut to 10-35 lb in. and secure with a cotter key.

e. Adjust rod end on free end of fuel cutoff tie rod until the holes in the rod end and fuel control fuel cutoff lever align. Attach the rod end to the lever with a bolt and nut. Tighten the nut to 10-35 lb in. and secure with a cotter key.

f. Ensure that the threaded ends of the rod extend into the rod ends past the inspection hole to assure adequate thread engagement; then lockwire the jam nuts.

g. Remove the rigging pin and rotate the coordinator condition lever toward the maximum position (clockwise). Check the coordinator fuel cutoff outrigger lever for freedom of movement.

h. Rotate the coordinator condition lever toward the minimum position (counterclockwise) and check that the governor minimum stop position and fuel cutoff occur simultaneously. Condition lever movement is limited by the stops on the propeller governor lever. The rigging pin should insert freely.

**3-105. Procedure D—Gas Producer Lever.** The coordinator gas producer lever (D, figure 3-16) is connected to the gas producer fuel control gas producer lever as follows:

a. Place the coordinator input power lever at the 95° position (TAKEOFF position on the protractor.)

b. Place fuel control gas producer lever against the maximum speed stop (rotated clockwise). The lever should be approximately 45° aft of vertical. If the lever requires repositioning, loosen the nut, reposition, then tighten the nut to 40-50 lb in.

----- CAUTION -----

*Overtorquing causes binding of the lever shaft.*

-----

c. Adjust the gas producer control tie rod until the holes in the rod ends align (approximately) with the holes of the fuel control gas producer lever and the coordinator gas producer lever.

d. Attach the gas producer control tie rod to the coordinator gas producer lever by installing a bolt and nut. Tighten the nut to 10-35 lb in. and secure with a cotter key.

e. Adjust the rod end on the free end of the gas producer control tie rod until the holes in the rod end and the fuel control gas producer lever align. Attach tie rod to the lever with a bolt and nut. Tighten the nut to 10-35 lb in. and secure with a cotter key.

f. Ensure that the threaded ends of the rod extend into the rod ends past the inspection hole to assure adequate thread engagement; then lockwire the jam nuts.

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g. Move the input power lever to the position which provides the maximum reset of the fuel control gas producer lever. In this position the gas producer lever rotates clockwise with either a forward or rearward movement of the coordinator input power lever. The fuel control gas producer lever should be approximately  $\frac{3}{16}$  inch from the minimum speed stop.

h. Return the coordinator input power lever to the 95° (TAKEOFF) position and check that the fuel control gas producer lever is against the maximum speed stop.

i. Rotate the coordinator input power lever and check for freedom of movement. The lever must move freely without evidence of binding.

**3-106. Procedure E—Beta Control Lever.** The coordinator beta control lever (E, figure 3-16) is connected to the beta control rod (propeller part) as follows:

----- **NOTE** -----

*Always rig the beta control lever before setting the propeller blade angle.*

-----

a. Establishing Beta Valve Initial Rigging Position. Measure and record the initial rigging position for (1) original beta valve installations, (2) field replacement assemblies, and (3) field replacement of individual beta valve parts as follows:

- (1) Remove the propeller from the propeller mounting flange.
- (2) Remove the beta valve from the propeller gearbox.

(3) Reinstall check nut, rod end fitting and end cap (with O-ring) on the aft end of the beta control rod. (See figure 3-16A.)

(4) Push beta control rod into sleeve until it bottoms out. Install a 0.185-in. (4.70 mm) diameter pin through the beta valve port (See figure 3-16A.)

(5) Gently pull the beta control rod rearward until the rear face of the spool land contacts the pin without any excessive force or "slamming" of parts.

(6) While holding the assembly in this position, measure the distance (dimension A, figure 3-16A) between the rod end cap rear face and pin end. Record measurement as the beta valve rigging dimension A in the Engine Assembly (white pages) Inspection—Maintenance—Overhaul Record, Part IV of the Engine Log Book.

(7) Remove the pin from the beta valve port.

(8) Move spool back and forth throughout its travel to ensure operation is smooth and free from any binding.

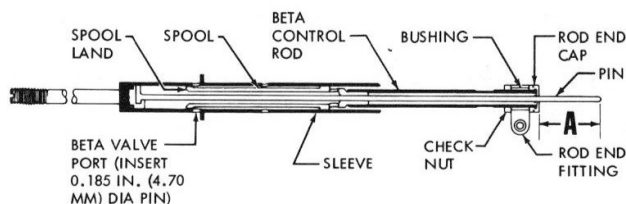
(9) Install the beta valve and propeller.

(10) Rig the beta control valve in accordance with one of the following procedures.

----- **NOTE** -----

*Refer to the aircraft manufacturers maintenance manual to determine if the Propeller Installed or the Propeller Removed procedure is recommended.*

-----



16340

Figure 3-16A. Beta Valve Schematic



b. Procedure E – Propeller Installed. Connect coordinator beta control lever to the beta valve using the beta valve rigging dimension **A** (Recorded in the Engine Assembly Inspection—Maintenance—Overhaul Record, Part IV of the Engine Log Book) as follows:

----- **NOTE** -----

*Always rig the coordinator to the beta valve linkage before setting the propeller blade angle.*

-----

- (1) Place the coordinator input lever at the 95° position (TAKEOFF position on the protractor).
- (2) Adjust the beta control rod until the distance between the rear face of the rod end cap and pin end equals the recorded rigging dimension **A**. (See figure 3-16B.)
- (3) Adjust beta control tie rod length until the holes in the rod ends align (approximately) with the holes in the coordinator beta control lever and the beta control rod.
- (4) Attach the beta control tie rod and adjustment plate to the coordinator beta control lever with a bolt and nut. The adjustment plate must be positioned on the lever so that the scribed lines on the lever and plate are aligned. Tighten the nut to 10-35 lb in. (1.1 - 3.9 N-m) and secure with a cotter pin.
- (5) Adjust the rod end on the free end of the beta control tie rod until the holes in the rod end and the beta control rod align. Attach the tie rod to the beta control rod with a bolt and nut (aircraft furnished). Tighten the nut to 10-35 lb in. (1.1 - 3.9 N-m) and secure with a cotter pin (aircraft furnished).
- (6) Ensure that the threaded ends of the rod extend into the rod ends past the inspection hole to assure ade-

quate thread engagement; then tighten jam nuts and lock-wire.

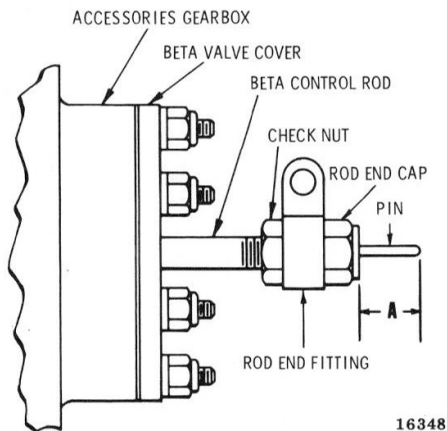
c. Procedure E – Propeller Removed. Where it is inconvenient to remove the propeller to establish the initial rigging position, use the following procedure:

----- **NOTE** -----

*Always rig the coordinator to the beta valve linkage before setting the propeller blade angle.*

-----

- (1) Disconnect the coordinator beta control lever from the beta control rod.
- (2) Place the coordinator input lever at the 95° position (TAKEOFF position on the protractor).
- (3) Firmly push in the beta control rod by hand until it bottoms out. (Do not compress the beta valve springs.)
- (4) Measure the distance between the beta valve cover and rod end cap. (See figure 3-17.) Record measurement as dimension **D**.
- (5) Pull out the beta control rod until the rod end cap is 1.08 in. (27.4 mm) from dimension **D** (figure 3-17.)
- (6) Adjust beta control tie rod length until the holes in the rod ends align (approximately) with the holes in the coordinator beta control lever and the beta control rod.
- (7) Attach the beta control tie rod and adjustment plate to the coordinator beta control lever with a bolt and nut. The adjustment plate must be positioned on the lever so that the scribed lines on the lever and plate are aligned. Tighten the nut to 10-35 lb in. (1.1 - 3.9 N-m) and secure with a cotter pin.
- (8) Adjust the rod end on the free end of the beta control tie rod until the holes in the rod end and the beta control rod align. Attach the tie rod to the beta control rod with a bolt and nut (aircraft furnished). Tighten the nut to 10 - 35 lb in. (1.1 - 3.9 N-m) and secure with a cotter pin (aircraft furnished).
- (9) Ensure that the threaded ends of the rod extend into the rod ends past the inspection hole to assure adequate thread engagement; then tighten jam nuts and lock-wire.



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**Figure 3-16B. Propeller Installed Beta Valve Rigging Position**

**3-107. PROPELLER AND BETA CONTROL VALVE.**

3-108. The following instructions are for the installation of the propeller and the beta control valve and for setting the propeller blade angle. Since the beta control valve and propeller are not engine components this information is limited to that which is needed for engine maintenance functions.

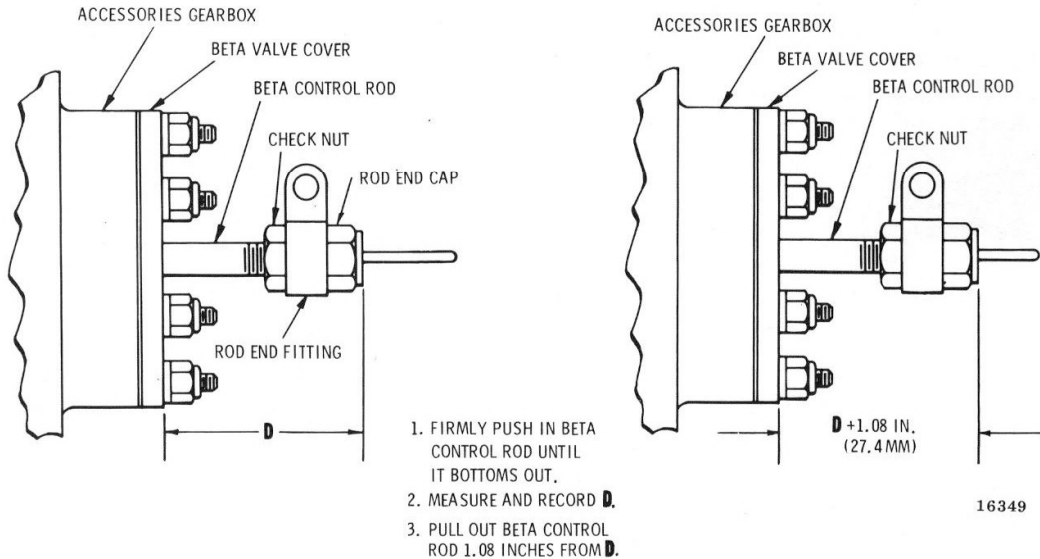


Figure 3-17. Propeller Removed Beta Valve Rigging Position

**3-109. Beta Control Valve and Propeller Installation.**

Install the beta control valve and the propeller as follows:

- a. Remove the retaining ring from the ID of the propeller mounting flange.
- b. Loosen the check nut on the aft end of the beta valve and remove the rod end caps, rod end fitting and check nut.
- c. Lubricate the surface of the beta valve that mates with beta valve adapter with engine oil. Install the beta valve in the engine from the forward side. Insert the threaded end through the beta valve adapter inside the propeller shaft. The beta valve rod should protrude from the rear of the power and accessories gearbox.
- d. Install the beta valve inner and outer springs inside the propeller shaft and seat against the beta valve. Install the spring retainer in the propeller mounting flange and secure with the retaining ring which was removed in step a.

----- NOTE -----

*Approximately 30 lb force is required to compress the springs to install the spring retainer and retaining ring.*

- e. Fit the beta valve cover over the beta valve rod and secure to the power and accessories gearbox with six washers and self-locking nuts. Use care when installing the cover to prevent the threads on the beta valve rod from damaging the O-ring between the cover plate and rod.
- f. Install the check nut, rod end fitting and rod end caps (with O-ring) on the aft end of the beta valve rod.
- g. Install the propeller on the propeller mounting flange. Use care to prevent bending the beta valve rod as the propeller is being installed.



h. Rig the coordinator to beta valve linkage. (Refer to Rigging Procedure E, para 3-106.)

i. Set the propeller blade angle. (Refer to Propeller Blade Angle Setting, para 3-110.)

j. Install the spinner.

**3-110. Propeller Blade Angle Setting.** Set the propeller blade angle as follows:

a. Place the coordinator power lever in the 40° position (FLIGHT IDLE).

b. Place the coordinator condition lever in the maximum rearward position (rotated clockwise). The propeller-power turbine governor assembly (referred to as governor assembly) propeller governor lever will be at the maximum speed stop (fully rotated clockwise).

c. Disconnect the air line at the P<sub>y</sub> elbow of the governor assembly. (See figure 3-13.) Cap the opening.

d. Disconnect the oil line at the propeller control oil port of the governor assembly. Connect a regulated air or nitrogen supply of 100-120 psi (689-827 kPa) to the open port.

e. Apply pneumatic pressure and adjust the blade angle setting nut to achieve the required flight idle blade angle that is approved for the particular installation.

----- **NOTE** -----

*Turn nut clockwise to increase blade angle. One turn equals approximately one degree blade angle.*

f. Cycle coordinator power lever. Return to the 40° position.

g. Remeasure the blade angle and adjust as necessary. (See step e.)

h. Disconnect the pressurizing equipment from the governor assembly propeller control oil port. The propeller will automatically go to the feather position because of internal spring forces. Reconnect oil line to the port.

i. Remove cap and reconnect P<sub>y</sub> air line to the P<sub>y</sub> pressure port of the governor assembly.

3-110A. The following procedure may be used as an alternate method of setting propeller blade angle.

a. Place the coordinator power lever in the 40° position (Flight Idle).

b. Place the coordinator condition lever in the maximum rearward position (rotated clockwise). The propeller-power turbine governor assembly (referred to as governor assembly) propeller governor lever will be at the maximum speed stop (fully rotated clockwise).

c. Hold the feedback rod sleeve hard forward against the locknut. (See figure 3-17A.)

d. Adjust the blade angle setting locknut to obtain a clearance of 1.75 - 1.80 in. (44.45-45.72 mm) for 6° blade angle and 1.8 - 1.9 in. (45.72-48.26 mm) for 10° blade angle between the rear of the sleeve and the forward face of the pilot tube.

e. Conduct an engine run and check propeller rpm at Flight Idle (N<sub>1</sub> should be 60-62%). Propeller speed should be within 40 rpm of speed specified for the ambient temperature and desired blade angle. (See figure 3-17B.) If not within desired limits, adjust the clearance by changing the locknut (step d). Turn clockwise to increase blade angle and reduce N<sub>2</sub> rpm. One turn equals approximately 3% N<sub>2</sub> rpm.

**3-111. LUBRICATION SYSTEM.**

3-112. Lubrication system maintenance includes: cleaning and inspecting the magnetic drain plugs, changing the system oil, cleaning the oil filter, replacing the lube oil filter housing assembly, adjusting the pressure regulating valve, cleaning and inspecting the turbine pressure oil system check valve, and flushing the gas producer support oil supply passage.

----- **CAUTION** -----

*Do not use silicone lubricants except where specified. Use only the lubricants recommended in the engine publications.*

*Unless absolutely necessary, do not remove the gas producer turbine support pressure oil manifold. If this tube must be removed, refer to flushing procedure in Gas Producer and Power Turbine Pressure Oil Manifold, para 3-114.*

**3-112A. Oil Temperature Limit Exceeded.** The maintenance actions required when oil temperature limits have been exceeded are governed by the overtemperature conditions encountered. Specific conditions and their respective maintenance action requirements are given in the following paragraphs.

**3-112B. Oil Temperature Limit Exceeded During Operation Above 40 psi (276 kPa) T/M Pressure or 165 hp (123 kW).**

a. Engine oil temperature exceeds 180°F (82°C) but remains less than 225°F (107°C) for a period not exceeding 10 minutes. Oil pressure remains normal.

(1) Check for carbon deposits on the magnetic drain plugs or on the oil filter. (Use 6798860 puller to remove the filter cap.) If no carbon particles can be found, return the engine to service. If carbon particles are found during the magnetic plug or oil filter inspection, continue with the following inspections and maintenance actions.

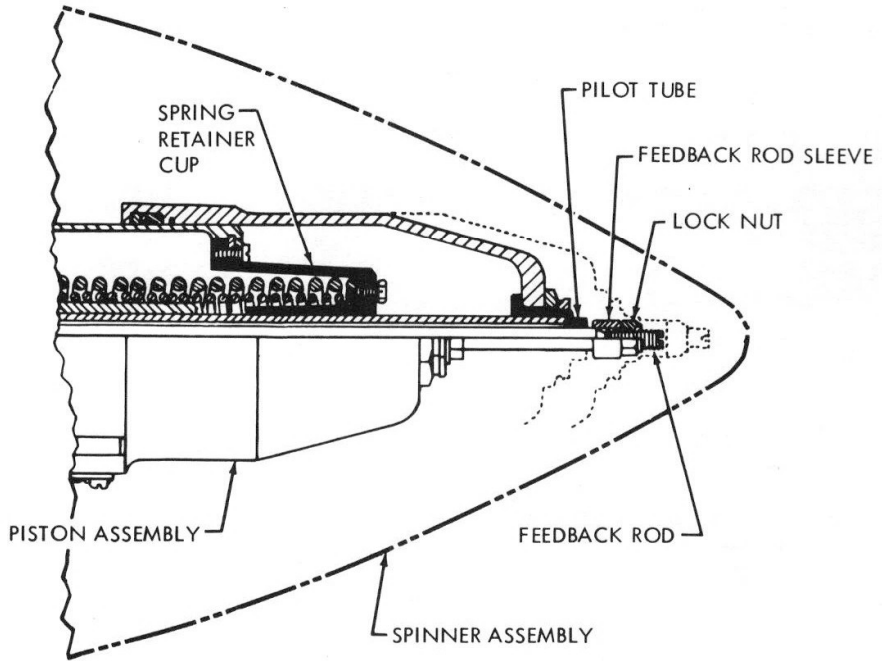


Figure 3-17A. Propeller Blade Angle Adjustment

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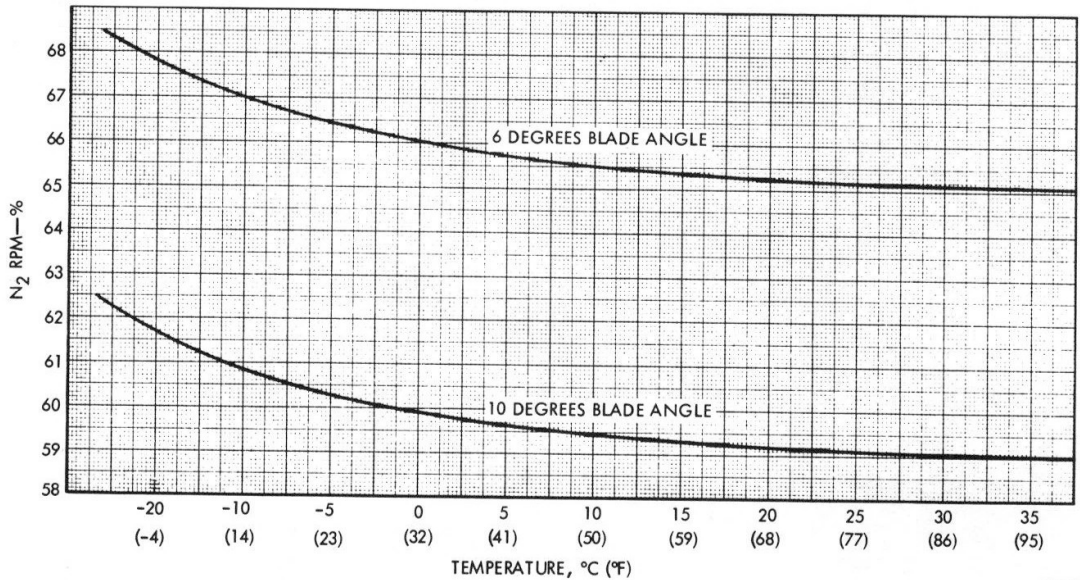


Figure 3-17B. N<sub>2</sub> Flight Idle Speed Variation vs Ambient Temperature

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(2) Check the extent of carbon buildup in the engine. (Refer to checking for Carbon Buildup, para 3-112D.)

(3) Reservice the oil system with new oil. Ground run the engine for 10 minutes.

(4) Reinspect the oil filter and the magnetic drain plugs. If no carbon particles can be found, return the engine to service. If carbon particles are found, repeat the maintenance procedure.

(5) Reinspect the oil filter and the magnetic drain plugs after five hours of engine operation. If carbon particles are found, repeat the maintenance procedure.

b. Engine oil temperature exceeds 180°F (82°C) but remains less than 225°F (107°C) for a period not exceeding 10 minutes. Oil pressure abnormal.

(1) Replace the oil filter housing assembly. (Refer to Replacing the Lube Oil Filter Housing, para 3-119.)

(2) Check for carbon deposits (coking). (Refer to Checking for Carbon Buildup, para 3-112D.)

(3) Inspect and clean or replace the oil filter. (Use 6798860 puller to remove the filter cap.)

(4) Inspect and clean the magnetic drain plugs.

(5) Reservice the oil system with new oil. Ground run the engine for 10 minutes. Adjust engine oil pressure as required.

(6) Reinspect the oil filter and magnetic drain plugs. If no carbon particles can be found, return the engine to service. If carbon particles are found, repeat the maintenance procedure.

(7) Reinspect the oil filter and the magnetic drain plugs after five hours of engine operation. If carbon particles are found, repeat the maintenance procedure.

c. Oil temperature exceeds 225°F (107°C) momentarily or 180°F (82°C) for a period exceeding 10 minutes.

(1) Remove the engine and send it to an overhaul facility for inspection or repair as required.

(2) Tag the engine indicating that max allowable operating oil temperatures were exceeded. Give the maximum temperature and the elapsed time.

**3-112C. Oil Temperature Limit Exceeded During Operation at 40 psi (276 kPa) T/M Pressure or 165 hp (123 kW) and Less.**

a. Oil temperature exceeds 248°F (120°C) momentarily or 225°F (107°C) for a period exceeding 10 minutes.

(1) Remove the engine and send it to an overhaul facility for inspection or repair as required.

(2) Tag the engine indicating that max allowable operating oil temperatures were exceeded. Give the maximum temperature and the elapsed time.

**3-112D. Low Oil Pressure Operation.** If deterioration in engine oil pressure is experienced, the following sequence of checks is suggested.

a. Check the quantity of oil in the tank to be sure it is adequate.

b. Remove, inspect, clean and reinstall the magnetic plugs and filter. (Use 6798860 puller to remove the filter cap.)

c. Confirm the pressure discrepancy using a direct reading gage.

d. Increase the pressure adjustment if necessary. Check the gage for change in pressure. If no change in pressure is evident as a result of the adjustment, continue with the sequence of checks to isolate and correct the fault.

e. Remove and check the bottom magnetic drain plug. Drain oil from the gearbox. Do not install the magnetic drain plug, after residual oil has drained, until a check for internal oil leakage has been made.

----- **NOTE** -----

*Leakage from the bottom drain port is an indication that the oil tube O-rings and/or oil pump may be leaking. Leakage will also be evident if the check valve is not properly seated.*

f. If bottom drain port leakage is evident, remove the oil filter housing from the gearbox. (Refer to Replacing the Lube Oil Filter Housing, para 3-119.) Replace part if any of the following conditions are noted and local repair not practical.

(1) Excessive wear at ID of oil-out port.

(2) Pressure regulating valve seat or poppet damage.

(3) O-ring seal deterioration.

g. Install acceptable oil filter housing.

h. If problem persists after oil filter housing replacement, internal leakage of the oil pump and/or leakage past the O-rings located at the oil pump ports are the probable causes. Ascertain fault by inspection and replace part as necessary. (Refer to applicable part of Gearbox Disassembly and Assembly, para 3-170A.)

**3-112E. Checking for Carbon Buildup.** Check for carbon particles in the engine or oil system as follows:

a. Drain the oil from the engine and from the oil tank. Drain oil through a clean cloth which is suitable for filtering (detecting) carbon particles.

b. Inspect the No. 8 bearing and sump area. Do not remove the oil tube and nozzle. (Refer to the appropriate



part of Gas Producer and Power Turbine Pressure Oil Manifold, para 3-114 for disassembly and assembly procedures.)

c. Rotate the gas producer rotor. Listen for abnormal noise and visually inspect for damage.

d. If carbon buildup is detected during the oil, sump, and rotor inspection, inspect and clean if necessary, the power turbine support scavenge oil strut. (Refer to Inspection and Cleaning of Power Turbine Support Scavenge Oil Strut., para 3-115A.)

**3-113. Oil Change.** Change the engine oil at the time interval specified in Allison 250 CSL-1002 or when oil contamination is encountered. (Refer to Magnetic Plug Inspection, para 3-120.)

a. Drain the engine oil supply tank. Where the installation permits, inspect the oil tank for carbon and sludge deposits. If deposits are found, remove the oil tank in accordance with the aircraft manufacturers recommendations. Clean the tank using a suitable solvent.

b. Remove the magnetic drain plugs from the power and accessories gearbox and the reduction gearbox. Allow residual oil to drain from the magnetic plug openings. Inspect the plugs in accordance with the Magnetic Plug Inspection paragraph. Clean the plugs with solvent. Dry with a clean cloth.

c. If contamination is the cause for oil change, remove, disassemble, clean and inspect the oil pressure reducer at the compressor front support inlet to the number one bearing. Clean ultrasonically or with perchlorethylene. Reject reducer assembly if thimble of restrictor has burrs or damage to the lands.

d. Remove the oil filter and O-ring from the filter housing. (Use 6798860 puller to remove filter cap.) Thoroughly clean the oil filter cavity of all residual oil and sludge. Take the necessary precautions to prevent residual oil from entering the engine cavity or standpipe. Clean the oil filter. (Refer to Oil Filter, para 3-116.)

----- **NOTE** -----

*Some engine bearings feature silver-plated separators. If minute silver particles are found in the engine oil filter, clean and reinstall the filter. These minute particles are due to normal bearing wear and are not cause for further corrective action.*

-----

e. Install the magnetic drain plugs. Use new O-rings lubricated with engine oil. Tighten plugs to 60-80 lb in. (6.78-9.04 N-m) and secure with lockwire.

f. Install new or cleaned oil filter with new O-ring. Install the filter cap with a new O-ring which has been lubricated with engine oil. Retain cap with two nuts and washers. Tighten nuts to 30-40 lb in. (3.39-4.52 N-m).

g. Fill the oil supply tank with approved oil. (Refer to Allison 250 CSL-1002 for a list of approved oils. Refer to Airframe Manual for proper quantity of oil.)

h. Motor the engine with the starter and without ignition until an indication of oil pressure is attained. When pressure is evidenced start the engine and operate at idle for five minutes. Monitor oil pressure continuously during the five minute run.



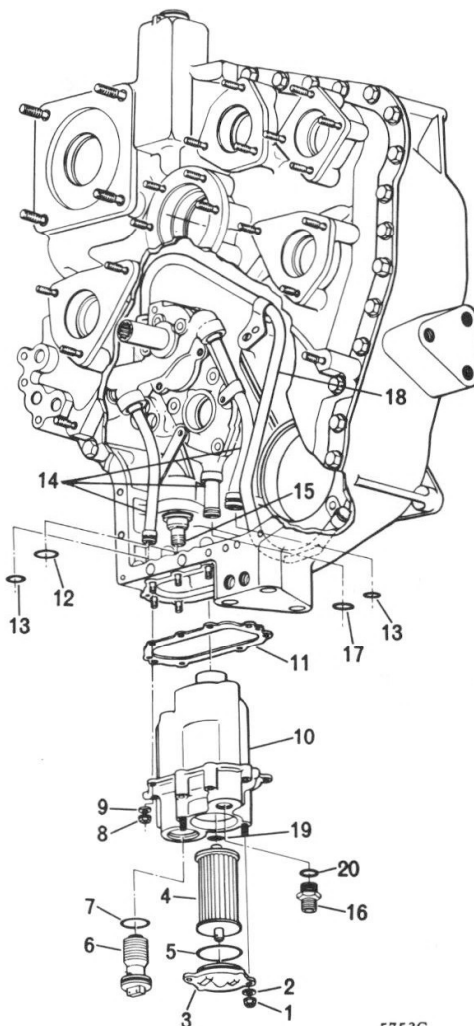
**3-114. Gas Producer and Power Turbine Pressure Oil Manifold.** Removal of the gas producer and power turbine pressure oil manifold is not recommended at the maintenance level as it may leave carbon contaminants in the support passage. If the manifold must be removed, flush the support passage as follows before reassembly.

- a. Remove the combustion section. (Refer to applicable part of Combustion Liner Inspection, para 3-161.)
- b. Remove the four bolts securing the gas producer and power turbine pressure oil manifold and remove the manifold. Discard the O-rings. (See figure 3-38.)
- c. Remove the two positioning plugs and separate the first-stage turbine nozzle shield from the turbine.
- d. Remove the G-type retaining ring.
- e. Remove the gas producer turbine sump and nut assembly using the sump wrench (L, figure 3-1).
- f. Remove the metallic asbestos gasket and bearing retaining plate.
- g. Remove the gas producer turbine bearing oil nozzle using the puller (F, figure 3-1).
- h. To keep the washing fluid from the rotor bearing area, turn the engine to a vertical position with the compressor end on top.
- i. Place a bucket beneath the engine then flow mineral spirits through the support passage into the bucket.

**3-115.** After flushing the gas producer turbine support passage, reassemble the engine as follows:

- a. Lubricate two O-rings and install with gas producer and power turbine pressure oil manifold on the turbine. Apply antiseize compound to the four retaining bolts; tighten to 35-40 lb in. and secure with lockwire.
- b. Blow through the installed manifold with clean compressed air to ensure that it is clear.
- c. Install the gas producer bearing oil nozzle using the puller (F, figure 3-1). Target the nozzle.
- d. Carefully coat the threads of the sump and nut assembly with antiseize compound. Position the metallic asbestos gasket and bearing retainer then install the sump and nut assembly using the sump wrench (L, figure 3-1). Tighten to 80-90 lb ft.
- e. Install the G-type retaining ring.
- f. Install the first-stage turbine nozzle shield on the turbine. Retain with two positioning plugs. Coat threads of plugs lightly with antiseize compound before installation. Tighten positioning plugs to 240-280 lb in. and secure with lockwire.
- g. Install the combustion section. (Refer to applicable part of Combustion Liner Inspection, para 3-161.)

**3-115A. Inspection and Cleaning of Power Turbine Support Scavenge Oil Strut.** When carbon buildup is found during the scheduled inspection, clean (as required) the power turbine support scavenge oil passage. Disassemble,

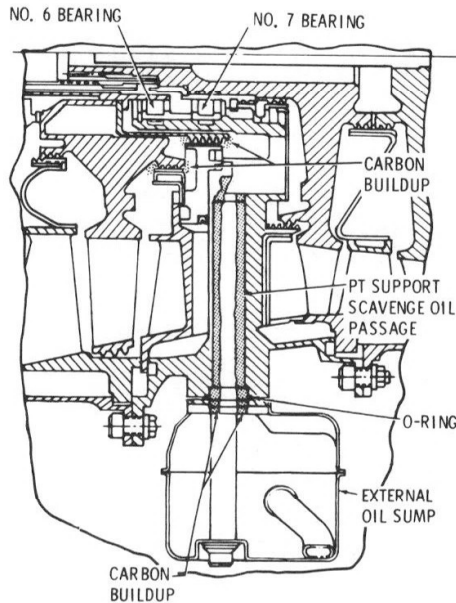


- |                              |                       |
|------------------------------|-----------------------|
| 1. Nuts (2)                  | 11. Gasket            |
| 2. Washer (2)                | 12. O-ring            |
| 3. Oil Filter Cap            | 13. O-ring (2)        |
| 4. Oil Filter                | 14. Transfer Tube (3) |
| 5. O-ring                    | 15. Check Valve       |
| 6. Pressure Regulating Valve | 16. Magnetic Plug     |
| 7. O-ring                    | 17. O-ring            |
| 8. Nuts (8)                  | 18. Scavenge Tube     |
| 9. Washers (8)               | 19. O-ring            |
| 10. Filter Housing           | 20. O-ring            |

**Figure 3-18. Oil Filter, Filter Housing, and Pressure Regulating Valve**

inspect, clean, and reassemble the power turbine oil system components as follows:

- a. Remove the coordinator. (Refer to applicable part of Coordinator Assembly, para 3-98.)



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**Figure 3-18A. Carbon Buildup in Power Turbine Support Scavenge Oil Strut and Rotating Labyrinth Seals**

b. Remove the eight bolts and nuts and separate the access panel from the fire shield.

c. Remove four bolts and separate the gas producer support pressure oil manifold from the engine. Remove the power turbine support pressure oil nozzle. Discard O-rings at three locations.

d. Remove the scavenge oil tube between the external sump and the elbow at the fire shield.

e. Remove the lockwire and the two external sump attaching bolts. Remove the sump. Discard the O-ring.

f. Inspect the power turbine support scavenge oil passage using a light and mirror. The cross section of the passage is approximately  $\frac{1}{2} \times \frac{5}{32}$  in. (12.7 X 4 mm). If carbon deposits (coke) are found, clean the passage; otherwise reassemble the oil passage components. (See figure 3-18A.)

g. Clean carbon deposits from the walls of the scavenge oil passage as follows:

(1) Use a soft wire with a hook bent at one end. Pull the carbon downward away from the bearing area.

(2) Force shop air or engine oil (in a hand pump-type oil can) through the power turbine support pressure oil strut to dislodge any loosened carbon.

(3) Clean carbon accumulation from inside the external sump. Rinse the sump with petroleum solvent and dry.

h. Flush the gas producer support pressure oil passage. (Refer to Gas Producer and Power Turbine Pressure Oil Manifold, para 3-114.)

i. Apply Permatex 1372 sealer lightly to the O-ring. Install O-ring at power turbine support drain port. Attach external sump; retain with two bolts. Tighten to 35-45 lb



in. (3.95-5.08 N-m) and secure with lockwire. Apply torque in small equal increments.

j. Install the scavenge oil tube between the external sump and the elbow at the fire shield. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N-m).

k. Lubricate O-ring and install it with the power turbine support pressure oil nozzle.

l. Lubricate two O-rings and install with the gas producer support pressure oil manifold. Apply antiseize compound to the four retaining bolts. Tighten bolts to 35-40 lb in. (3.95-4.52 N-m) and secure with lockwire.

m. Blow through the installed manifold with clean compressed air to ensure that it is clear.

n. Install the fire shield access panel. Secure with eight bolts and nuts. Tighten bolts to 22-26 lb in. (2.49-2.94 N-m).

o. Install the coordinator. (Refer to applicable part of Coordinator Assembly, para 3-98.)

**3-115B. Cleaning Power Turbine Labyrinth Seals.** Clean carbon buildup from the power turbine labyrinth seals as follows: (See figure 3-18A.)

a. Remove the turbine from the engine. (Refer to applicable part of Replacing the Turbine Assembly, para 3-158.)

b. Mount the turbine on 6799955 fixture. Retain the fixture at the rear gas producer support flange with two bolts. Position vertically with the turbine and exhaust collector support at the top.

c. Remove the 24 nuts and bolts from the splitline and carefully lift the turbine and exhaust collector support, with power turbine rotor assembly, from the power turbine support.

----- **NOTE** -----

*The two firewall shield retaining brackets and an oil tube clamp bracket are removed when the exhaust collector is separated from the power turbine support.*

d. Carefully remove carbon and coke deposits from the rotating labyrinth seal knives.

----- **CAUTION** -----

*Do not use a carbon remover on the stationary member of the labyrinth seal. Carbon remover will damage the nickel-graphite surface.*

e. Before reassembly of the exhaust collector-power turbine rotor assembly to the turbine, press the No. 6 bearing rollers outboard to create the maximum opening for passage of the bearing inner race. It may be necessary to use grease to retain the rollers in this position.

f. Reposition the turbine and exhaust collector support, with power turbine rotor assembly onto the power turbine support. Use care to prevent damage to the knife edges of the labyrinth seals and/or to the No. 6 bearing inner race or rollers.

g. Index the exhaust collector and power turbine supports as required. Apply antiseize compound; then install the four slab head bolts at the line reamed holes marked at production or overhaul during the alignment build. Rotate the power turbine rotor by hand to ensure that there is no binding.

h. Install the remaining 20 bolts and nuts, each lightly coated with antiseize compound. Alternately tighten nuts 180 degrees apart to 10-15 lb in. (1.13-1.69 N-m); then repeat the process tightening nuts of socket head bolts to 20-30 lb in. (2.26-3.39 N-m). If Tee-head bolts are used, tighten to 35-40 lb in. (3.95-4.52 N-m) plus prevailing torque.

i. Remove the turbine from 6799955 fixture. Install the turbine on the gearbox in accordance with the installation procedure given in para 3-159.

j. Check run the engine after turbine installation. (Refer to Check Run, para 3-174.)

**3-116. Oil Filter.** Remove, clean and install the oil filter as follows:

a. Place a container beneath the gearbox to catch oil which will drain when the cap is removed.

b. Remove the oil filter cap by removing two nuts and washers; remove oil filter and O-ring from housing. (See figure 3-18.) Discard O-ring.

c. Reinstall the cap while the oil filter is being cleaned.

d. Clean the filter ultrasonically. If equipment is not available, clean by agitating in mineral spirits. If excessive contamination is present the filter must be ultrasonically cleaned.

e. Dry the filter by shaking (air dry).

f. Remove the cap and replace O-ring.

g. Thoroughly clean the filter cavity of all residual oil and sludge.

h. Install the cleaned filter and new O-ring and cap. Tighten nuts to 30-40 lb in. (3.39-4.52 N-m).

**3-117. Pressure Regulating Valve.** (See figure 3-18.) Make necessary changes in the engine oil pressure by adjusting the pressure regulating valve.



----- **CAUTION** -----

*Do not make a pressure regulating valve adjustment to correct for a sudden increase or rapid change in oil pressure. These conditions are cause to suspect other oil system problems have developed.*

- 
- a. Remove the lockwire.
  - b. Using a wrench, turn the regulating valve clockwise to increase and counterclockwise to decrease oil pressure. An approximate adjustment may be made by bottoming the valve then backing it out 5-½ turns. One turn of the adjustment will change the oil pressure approximately 13 psig (90 kPa). Oil pressure is 120 ± 10 psig (827 ± 69 kPa) at 180°F (82°C) oil temperature.

**3-118. Turbine Pressure Oil System Check Valve.**

Disassemble, clean and inspect the check valve as follows: (See figure 3-18B.)

- a. Remove the fitting from the check valve housing.
- b. Separate the O-ring, spring and poppet from the housing. Discard O-ring.
- c. Wash parts in mineral spirits.
- d. Inspect valve parts in accordance with Table III-6B.
- e. Insert poppet and spring into valve housing.
- f. Install fitting with new O-ring on housing.
- g. Inspect check valve for external leakage at first engine operation after valve installation on the engine. No leakage permitted.

----- **CAUTION** -----

*Be sure the check valve is installed with the arrow pointing toward the rear of the engine.*

**3-119. Replacing the Lube Oil Filter Housing.** (See figure 3-18.) Replace the lube oil filter housing as follows:

- a. Place a container beneath the gearbox then remove the eight nuts and washers. Remove the housing and the gasket.
- b. Remove the magnetic plug from the filter housing assembly.
- c. Replace the O-ring seals on the filter housing mating ends of the two transfer tubes.
- d. Replace the O-ring seals on both ends of the check valve assembly.
- e. Replace the filter housing gasket. Install the replacement lube oil filter housing. Mate the housing to the two transfer tubes and to the check valve during the assembly.

f. Install the magnetic plug with new O-ring in the replacement housing.

g. Retain the lube oil filter housing with eight nuts and washers. Tighten nuts to 35-40 lb in. (3.95-4.52 N-m).

**3-120. Magnetic Plug Inspection.** Inspect the magnetic drain plugs as follows:

- a. If a warning light signal is received in the cockpit, remove and visually inspect the magnetic plugs.
- b. During visual inspection of magnetic plugs fuzz or hair-like magnetic particles can normally be found and are not cause for maintenance action beyond cleaning the plugs. If small chips or flakes are found proceed as follows:

----- **NOTE** -----

*Clean magnetic drain plugs in slovent. Use a brush to dislodge all debris. Wipe dry with a clean cloth. Inspect under magnification to ensure removal of all debris.*

-----

- (1) Change the oil, clean the magnetic plugs and clean the oil filter. (Refer to Oil Change, para 3-113.)

- (2) Make a 30 minute run. Visually check the magnetic plugs immediately after the run. If small chips or flakes continue to be found, remove engine, tag to show contamination as the cause of removal and send it to repair or overhaul facility.

----- **NOTE** -----

*When an engine has been rejected because of metal contamination in the oil, refer to the aircraft maintenance manual for the procedure to flush and clean or replace the applicable item in the airframe lube system.*

**3-121. IGNITION SYSTEM.**

3-122. Maintenance of the ignition system includes: cleaning and inspecting the spark igniter, inspecting the ignition exciter and spark igniter lead, and making an ignition check.

**3-123. Spark Igniter.** Remove, inspect, clean and install the spark igniter as follows: (See figure 3-19.)

----- **WARNING** -----

*Make sure that the ignition switch is off before removing the spark igniter or spark igniter lead assembly as dangerously high voltages may be present.*



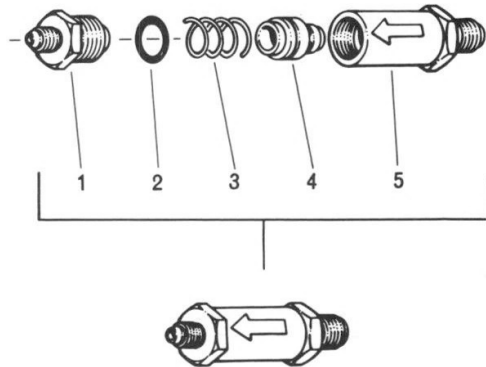
**Detroit Diesel Allison**  
Division of General Motors Corporation

250 - B17 Operation and Maintenance

TABLE III-6B

Turbine Pressure Oil System Check Valve Inspection

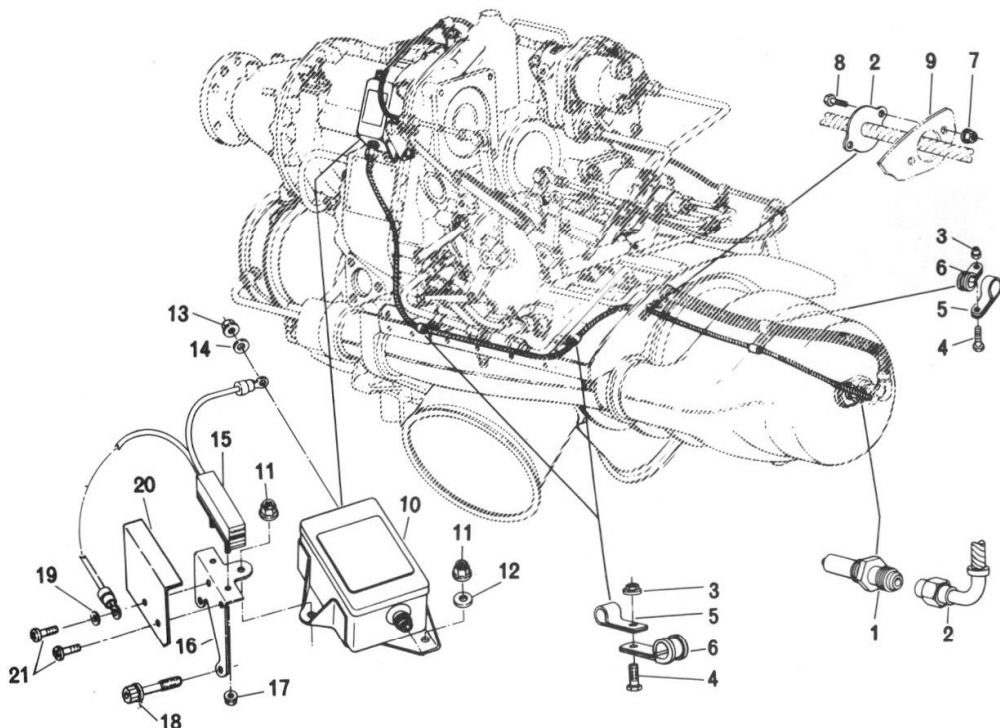
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
1	Stripped or crossed threads on fitting or housing.	None.	Max of one damaged thread.	Chase threads.
2	Nicks or scratches on flared tube sealing surface of fitting or housing.	None.		Repair or replace part.
3	Nicks or scratches on poppet seating surface or housing valve seat.	None.		Repair or replace part.



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- 1. Fitting
- 2. O-ring
- 3. Spring
- 4. Poppet
- 5. Housing

Figure 3-18B. Turbine Pressure Oil System Check Valve



- |                  |              |                      |                   |              |                        |
|------------------|--------------|----------------------|-------------------|--------------|------------------------|
| 1. Spark Igniter | 5. Clamp (3) | 9. Fire Shield       | 13. Nut           | 16. Bracket  | 19. Washer             |
| 2. Ignition Lead | 6. Clamp (3) | 10. Ignition Exciter | 14. Washer        | 17. Nut (2)  | 20. Protective Bracket |
| 3. Nut (3)       | 7. Nut (2)   | 11. Nut (3)          | 15. Start Counter | 18. Bolt (2) | 21. Screw (2)          |
| 4. Bolt (3)      | 8. Bolt (2)  | 12. Washer (2)       |                   |              |                        |

9458A

Figure 3-19. Engine Electrical System Assembly

a. Disconnect the ignition lead at the igniter. Hold the lead to prevent its twisting while removing the nut. Separate the lead from the igniter by pulling straight out with no rotational motion.

----- CAUTION -----

*The exciter and the igniter connector wells should be kept dry and free from foreign material. Clean by wiping with a clean dry cloth, if required. Do not wash with solvent.*

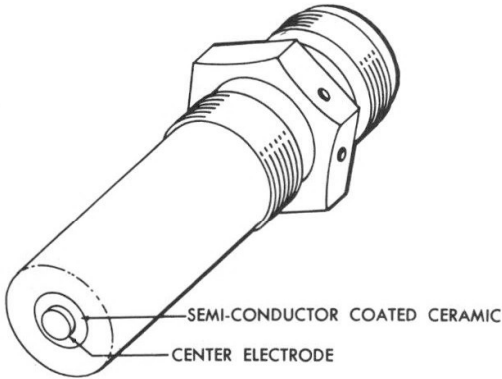
- b. Unscrew the igniter.  
 c. Inspect the center electrode; replace igniter if the electrode is loose. (See figure 3-20.)  
 d. Inspect the ceramic for cracks. If any cracks are visible through the carbon coating replace the igniter.

----- NOTE -----

*Normal soot or carbon formation on the tip is not detrimental to the operation of the spark igniter and need not be removed. If cleaning is desired, for some special reason, wipe the metal tip with a soft cloth only. Remove any sizeable lump of carbon with a blunt instrument. Be careful not to damage the semi-conductor material.*

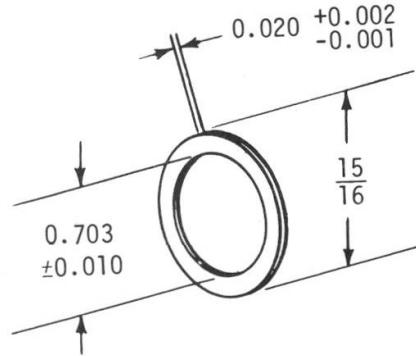
----- CAUTION -----

*Under no circumstances should the spark igniters be cleaned by wire brushing, sand blasting, vapor blasting or scraping on the igniter tip. Any of these practices can damage the semi-conductor material between the two electrodes and result in shortened spark igniter life or immediate spark igniter failure.*



4364

Figure 3-20. Spark Igniter



BREAK SHARP EDGES

Figure 3-21. Spark Igniter Shim

6292

e. Inspect spark igniter for fretting wear. Wear of 0.032 in. max is serviceable without corrective action. Wear of 0.032 in. or more is acceptable if it does not affect the function of the spark igniter and if the following corrective action is taken:

(1) Fabricate a shim from corrosion resistant steel shim stock to the dimensions given in figure 3-21.

(2) At installation of the spark igniter, place the fabricated shim between the outer combustion case and the igniter.

----- NOTE -----

*A shim sized per figure 3-21 will reduce the spark igniter installed thread length by 1/2 turn. Localized fretting is thereby moved 180° from the wear area of the previous installation. Be sure to remove the shim when a new spark igniter is installed.*

f. Check the general condition of the spark igniter; replace if excessive erosion is evident.

g. Check the operation of the spark igniter after it has been removed from the engine. Apply 28 volts dc to the exciter and observe the rate of firing. Normal operation is six sparks per second minimum. Replace the spark igniter if it fails to fire or fires intermittently.

----- NOTE -----

*Do not replace the spark igniter as defective until the ignition exciter is known to be acceptable. (Refer to Ignition Exciter, para 3-124.)*

h. Install serviceable spark igniter; tighten to 150-200 lb in. and lockwire to fuel nozzle. Connect ignition lead; tighten to 70-90 lb in.

**3-124. Ignition Exciter.** Remove, inspect and install the ignition exciter as follows: (See figure 3-19.)

----- WARNING -----

*Make sure that the ignition switch is off before removing the spark igniter or spark igniter lead assembly as dangerously high voltages may be present.*

- a. Disconnect the electrical leads from the exciter.
- b. Remove the two bolts which secure the start counter bracket and start counter lead to the gearbox.
- c. Remove the ignition exciter, start counter and bracket by removing the three nuts and two washers.
- d. Connect a known satisfactory lead and spark igniter of the type used on the engine to the ignition exciter.

----- CAUTION -----

*Do not energize ignition exciter if spark igniter and lead are disconnected.*

e. Apply 28 volts dc to the input terminal of the ignition exciter using a minimum wire size of 16 gage. Observe firing. If a repetitive spark rate of less than 6 sparks per second is observed, replace the ignition exciter.

Figure 3-22 deleted.



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f. Apply 14 volts dc to the input of the ignition exciter if there is any question about its operation. The spark rate should not be less than three sparks per second and should be uniform.

g. Install the ignition exciter on the gearbox. Retain at each end with a washer and nut. Do not install the forward nut at this time. Tighten the two end nuts to 30-40 lb in.

h. Place the start counter and bracket on the exciter forward mounting stud. Secure the bracket and start counter white lead to the gearbox at the No. 3 bolt position (as viewed from the front of the engine) with a washer and bolt. Secure the bracket at the No. 4 position with a bolt. Install the nut on the forward mounting stud. Tighten the nut and bolts to 35-40 lb in.

i. Connect the igniter lead to the ignition exciter. Tighten the coupling nut to 70-90 lb in.

j. Place the start counter black lead on the exciter input terminal. Place the seal lug on the input terminal and secure with a washer and nut.

**3-125. Start Counter.** In the event of a malfunction of the start counter, replace as follows:

a. Remove the start counter leads from the exciter and from the exciter bracket.

b. Remove the two nuts and washers that retain the bracket to the gearbox. Remove the counter from the bracket.

c. Install a serviceable start counter on the bracket. Retain with two nuts; tighten nuts to 5-8 lb in.

d. Place the counter-bracket assembly on the gearbox. Retain with the third (forward) ignition exciter attachment nut and two reduction gearbox attachment bolts and washers. Attach the counter white lead to the gearbox at the short leg of the counter bracket. Tighten nuts and bolts to 35-40 lb in.

e. Connect the counter black lead to the exciter input terminal.

f. Record the number of accumulated starts from the old counter in the engine log.

----- **NOTE** -----

*Refer to paragraph V. Adjustments for Invalid Start Counter Readings in 250 TP CSL-1005 for the procedure to be used when the cycles recorded on the start counter are known to be incorrect.*

3-135A. An alternate procedure may be used in the event of start counter malfunction. Counter replacement is not necessary provided:

a. The counter leads are disconnected from the exciter.

b. The number of accumulated starts is recorded in the Engine Log.

c. Starts are accurately counted and recorded by pilots and mechanics for entry into the Engine Log.

**3-126. Spark Igniter Lead.** Remove, inspect and replace the spark igniter lead as follows: (See figure 3-19.)

a. Inspect the outer part of the lead for braid damage; replace lead if damage is excessive.

b. Remove the lead from the ignition exciter and the spark igniter; detach from retention clamps.

c. Inspect ends of the lead to be sure all parts are intact.

d. Reinstall cable in reverse order of removal. Tighten igniter coupling to 70-90 lb in.; tighten exciter coupling to 50-70 lb in.

**3-127. Ignition Check.** A procedure for checking the engine ignition is as follows:

a. Remove the spark igniter lead from the spark igniter.

b. Remove the spark igniter.

c. Attach the spark igniter lead to the spark igniter.

----- **CAUTION** -----

*Turn the lead nut and not the spark igniter when assembling or disassembling a lead and an igniter which is not installed on the engine.*

d. Apply 28 volts dc across the ignition exciter. Observe or listen for spark.

----- **WARNING** -----

*To prevent electrical shock, allow five minutes following operation or test for electrical dissipation before installing the spark igniter lead.*

e. Install spark igniter and spark igniter lead on the engine. Tighten the spark igniter to 150-200 lb in. and lockwire to the fuel nozzle. Tighten the lead to 70-90 lb in.

**3-128. TEMPERATURE MEASUREMENT SYSTEM.**

3-129. Temperature measurement system maintenance consists of inspection and replacement of the thermocouple assembly.

**3-130. Thermocouple Inspection.** Make a visual and electrical check of the thermocouple assembly.

a. Visual. Visually inspect the thermocouple harness assembly for wear, broken leads or other damage. Using a strong light and 10X magnification, inspect the thermocouple tips for cracks, erosion, and scale. Replace thermocouple assembly for any of the following reasons:

- (1) Excessive wear or damage to the leads.
- (2) Tip breaks or cracks detected by magnification.



(3) Probes or tips which indicate melting or show other evidence of overtemperature.

(4) Tips which evidence erosion to the point that either wire has been reduced in area an estimated 25% or more.

----- **CAUTION** -----

*Direct the grit blast on the tips perpendicular to the probe axis - not on the end of the probe where the insulation could be eroded. After the scale is removed, reinspect the tip for cracks using a strong light and 10X magnification.*

(5) Tips having scale on either wire affecting 25% of the cross sectional area. If the thermocouple is otherwise satisfactory, remove the scale by soft grit blast.

b. Electrical. The electrical check of the thermocouple assembly consists of a continuity check and an insulation check.

----- **NOTE** -----

*When performing any electrical check on an installed thermocouple harness assembly, at least one harness lead must be disconnected from the fireshield junction block. Disconnecting one lead isolates the thermocouple assembly from the airframe temperature measurement system.*

(1) Continuity check. The internal resistance of an acceptable thermocouple harness assembly measured across the alumel and chromel leads, is 0.55 to 0.65 ohms at room temperature. An open circuit in the harness assembly will cause this resistance to be high; a short circuit will cause it to be low.

----- **CAUTION** -----

*A hot engine will cause the thermocouples to generate a small potential which will produce errors in measured internal resistance values. An approximate value may be obtained by reversing the leads and averaging the readings.*

----- **NOTE** -----

*A check of these limits can be performed only by using test instruments that offer useable sensitivity in this range (null-type resistance bridge or an especially designed test instrument such as the Barfield Model 2312G). If such instrumentation is not available, an ohmmeter (Simpson Meter or equivalent) can be used to detect an open circuit.*

(2) Insulation check. The minimum acceptable resistance to ground to 2,000 ohms. Carbon buildup on the probe tip will cause a short to ground. If resistance measures less than 2,000 ohms, clean carbon deposits from the probe using a clean soft cloth or by salt/grit blast. Repeat the check after cleaning the tip.

----- **CAUTION** -----

*Engine thermocouples should never be immersed or sprayed with cleaning solvents. Liquid cleaning solvents will penetrate the porous magnesium oxide insulation. Engine heat will vaporize the solvents leaving a residue containing carbon which causes a low resistance to ground.*

(a) On installed thermocouple assemblies, connect a portable multimeter between either harness lead and any probe flange.

(b) On uninstalled thermocouple assemblies, connect a portable multimeter between either harness lead and each of the four probe flanges.

(c) On uninstalled thermocouple assemblies, resistance to ground may also be checked by applying 1200 ±50°F (650±28°C) temperature to each thermocouple in succession (JetCal and kit BH8001, or equivalent). The harness should indicate an upscale reading on the millivolt meter and a gradual increase in resistance. If the resistance of each probe increases above 2000 ohms during the hot check, the harness is acceptable. Low resistance can be caused by carbon formation on the probe tip and/or magnesium oxide insulation shorting the probe to ground. If the resistance of any probe decreases or indicates a dead short, replace the thermocouple harness.

**3-130A. Thermocouple Replacement.** Replace the thermocouple assembly as follows:

a. Remove the coordinator assembly. (Refer to Coordinator Assembly, para 3-98.)

b. Remove the eight bolts and washers and remove the fire shield excess panel.

c. Remove the two thermocouple bracket mounting bolts and nuts; separate the bracket from the turbine.

d. Remove the eight thermocouple junction mounting bolts.

e. Remove the thermocouple assembly starting at either end. Discard gaskets.

f. Install replacement thermocouple with new gaskets in reverse of the order of removal. Tighten the eight junction mounting flange bolts to 30-40 lb in. (3.39-4.52 N-m), the two bracket bolts to 20-30 lb in. (2.26-3.39 N-m) and the terminal nuts to 18-24 lb in. (2.03-2.71 N-m)

g. Check run the engine after thermocouple replacement. (Refer to Check Run, para 3-174.)



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**3-131. ANTI-ICING AIR SYSTEM.**

3-132. Anti-icing system maintenance includes removal of the valve from the engine, inspection of the valve, replacement of the poppet seat, and installation of the valve on the engine.

**3-133. Anti-icing Air Valve.** Remove, clean, inspect and install the anti-icing air valve as follows: (See figure 3-24.)

- a. Disconnect the anti-icing air lines from the valve.
- b. Disconnect the linkage from the valve control arm.
- c. Remove the valve assembly.
- d. Disassemble the valve assembly.
  - (1) Remove the cotter pin, washer and pin. Detach

the actuating lever from the valve. Discard the cotter pin.

(2) Remove the lockwire and unscrew the poppet guide assembly from the valve body. Separate the poppet assembly from the body.

- e. Clean valve components in mineral spirits.
- f. Inspect the anti-ice valve components in accordance with table III-7.
- g. Assemble the valve assembly.

(1) Insert the poppet into the valve body.

(2) Screw the poppet guide assembly into the body. Tighten the coupling nut to 65-75 lb in. (7.34-8.47 N·m). Do not lockwire at this time.



(3) Align the actuating lever with the hole in the poppet guide assembly (notch in lever toward the guide) and insert the pin. Secure the pin with a washer and cotter pin. Lockwire the poppet guide to the valve body.

h. Apply antiseize compound lightly to the threads then install the valve with new O-ring in the scroll.

i. Reconnect linkage and air lines.

(1) Tighten coupling nuts of air tubes to 150-200 lb in. (16.95-22.60 N-m).

(2) Tighten valve-to-scroll jam nut to 100-150 lb in. and secure with lockwire.

----- **NOTE** -----

*For convenience of installation the anti-icing valve may be rotated 360°. Position valve as desired for the installation, then tighten coupling nut to 65-75 lb in. (7.34-8.47 N-m) and secure with lockwire.*

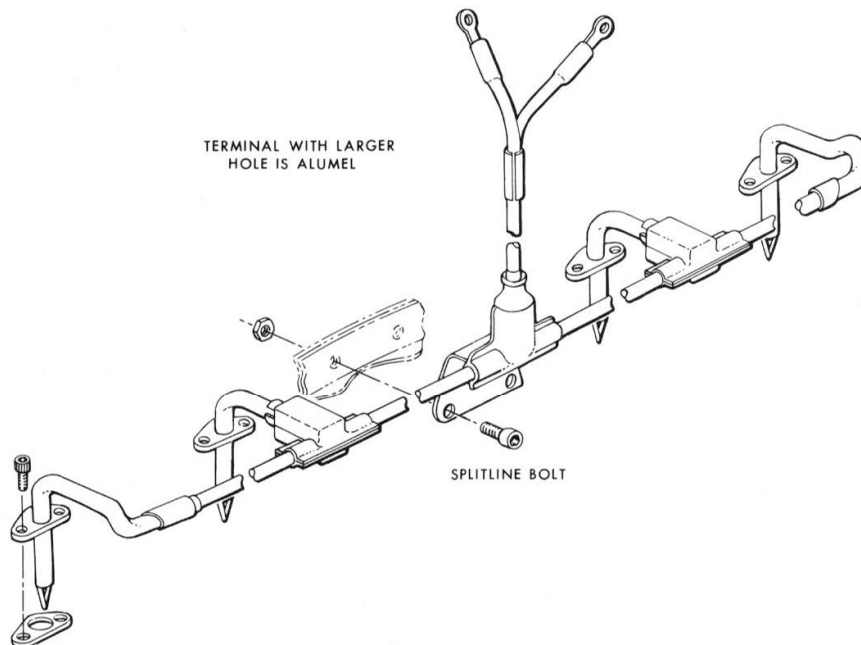
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3-134. Recheck the valve for leakage during first engine operation following installation of the repaired valve. Replace the valve assembly if leakage is still excessive.

**3-135. BLEED AIR SYSTEM.**

3-136. Bleed air system maintenance includes testing, cleaning, and replacing the bleed control valve.

**3-137. Bleed Air Control Valve.** Test the bleed control valve on an installed engine. Clean the valve if it does not operate in the range given in figure 1-10. (Clean the valve in accordance with Bleed Valve Cleaning, para 3-138.) Replace the valve as follows if cleaning does not bring the valve into the desired operating range. (See figure 3-24.)



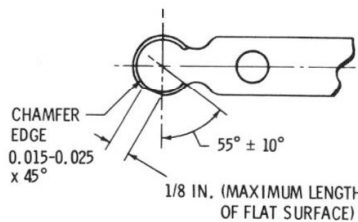
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Figure 3-23. Thermocouple Assembly



TABLE III-7

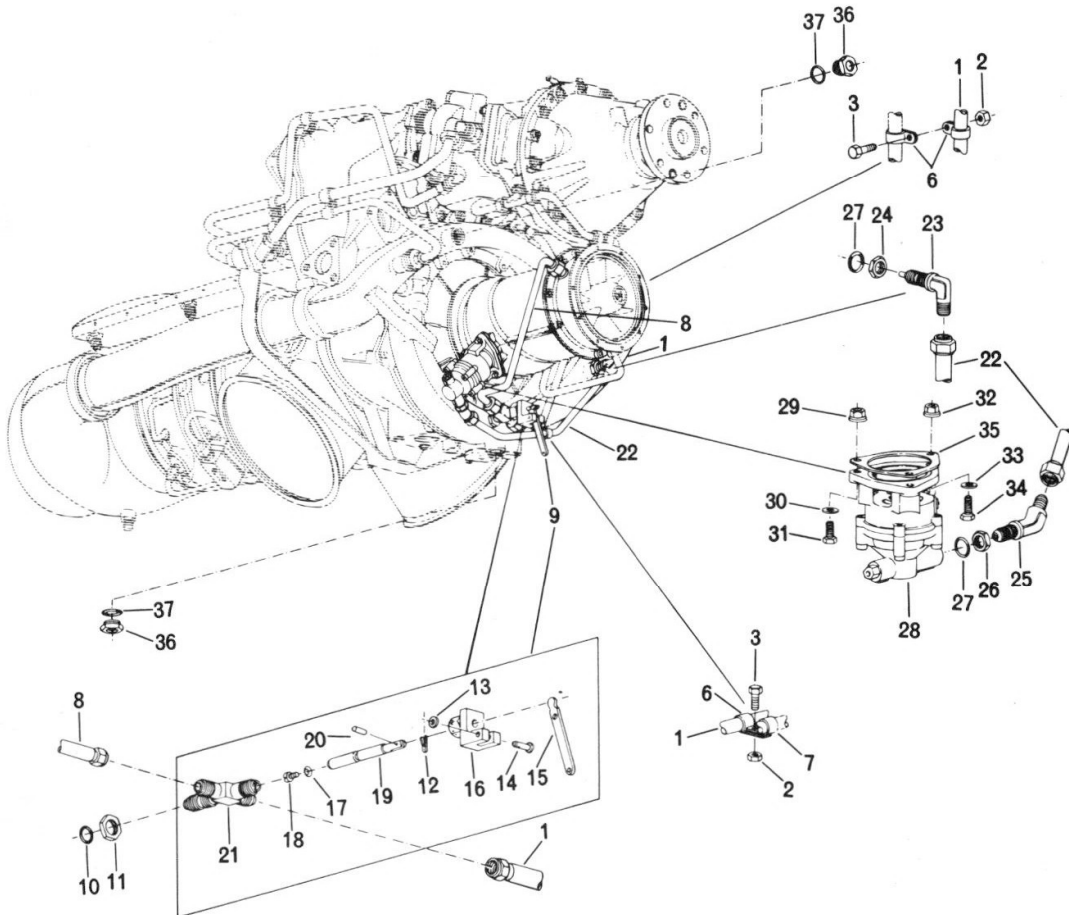
Anti-icing Air Valve Inspection and Repair				
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
1	Lever wear at poppet mating surface (creating flat).	Max flat length of 1/16 in.		Repair by grinding rounded end in accordance with figure 3-24A or replace lever.
2	Wear at hole for airframe linkage.	Remaining wall thickness not less than 0.040 in.		Repair or replace lever.
3	Nicks or scratches in flared tube sealing surfaces of valve body.	None.		Repair or replace valve body.
4	Stripped or crossed threads on valve body or coupling nut of the poppet guide.	None.	Max of one damaged thread per connection.	Chase threads.
5	Poppet wear.	Max wear step of 0.005 in.		Replace poppet.
6	Poppet seat damage or wear (excessive valve leakage).	None.		Remove screw and separate seat from poppet. Install new seat. Retain seat with a screw. Stake screw securely. (See fig. 3-25.)



GRIND ROUNDED END ONLY ENOUGH  
TO REMOVE FLAT SURFACE

9385

Figure 3-24A. Anti-icing Valve Lever Repair



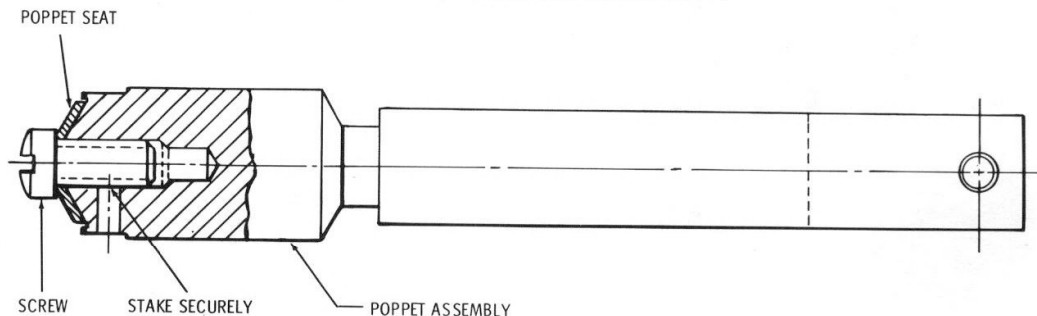
- 1. LH Anti-icing Air Tube
- 2. Nut (2)
- 3. Bolt (2)
- 4. Deleted
- 5. Deleted
- 6. Clamp (3)
- 7. Clamp
- 8. RH Anti-icing Air Tube
- 9. Anti-icing Valve Assembly
- 10. O-ring
- 11. Nut
- 12. Pin

- 13. Washer
- 14. Pin
- 15. Lever
- 16. Poppet Guide
- 17. Poppet Seat
- 18. Screw
- 19. Poppet
- 20. Pin
- 21. Valve Body
- 22. Air Sensing Tube
- 23. Pressure Probe Elbow
- 24. Nut

- 25. Elbow
- 26. Nut
- 27. O-ring
- 28. Bleed Valve
- 29. Nut
- 30. Washer
- 31. Bolt
- 32. Nut (2)
- 33. Washer (2)
- 34. Bolt
- 35. Gasket
- 36. Plug (2)
- 37. O-ring (2)

9461D

Figure 3-24. Engine Air System (Anti-icing and Bleed Air)



9484

Figure 3-25. Anti-Icing Valve Poppet Seat Replacement

a. Disconnect the compressor discharge pressure sensing tube assembly by loosening the coupling nut at the valve elbow.

b. Remove the three bolts, nuts and washers. Separate the bleed control valve and gasket from the mounting flange on the compressor case. Discard gasket.

c. Remove the elbow from the bleed valve. Discard the O-ring.

d. Lubricate a new O-ring and install it on the elbow. Install the elbow in the new bleed valve. Do not tighten the jam nut at this time.

e. Apply anti-seize compound to the bolt threads, then install the replacement bleed control valve and gasket on the mounting flange. Retain with three bolts, nuts, and washers. Assemble with washers beneath bolt heads. Tighten the ¼-28 nut to 70-85 lb in. Tighten the other two nuts to 35-40 lb in.

f. Attach the compressor discharge pressure sensing tube assembly to the bleed control valve with the coupling nut. Tighten coupling nuts to 80-120 lb in. Tighten the elbow jam nut to 55-80 lb in.

**3-138. Bleed Valve Cleaning.** Clean the bleed valve nozzle, filter, and jet as follows:

a. Remove the air sensing line from the bleed valve elbow. (See figure 3-24.)

b. Remove the elbow from the bleed valve. Discard the O-ring.

c. Remove the internal retaining ring and separate the filter from the bleed valve. (See figure 3-26.) Replace the retaining ring before assembly if it is damaged during the removal operation.

d. Using a screwdriver, remove the jet from the bleed valve.

e. Clip the lockwire then remove the nozzle and strainer from the bleed valve.

f. Clean the nozzle, filter, and jet ultrasonically in mineral spirits if equipment is available. If ultrasonic equipment is not available, agitate the parts in a clean container of mineral spirits. Use a soft bristle brush to clean exposed surfaces. Insert a sewing thread through the jet hole. Slide the jet back and forth on the thread to remove film. Clean the nozzle in the same manner.

----- CAUTION -----

*Do not blow the jet dry. The small jet can be easily lost or damaged.*

----- NOTE -----

*If the jet must be replaced, return the bleed valve to overhaul for part replacement and recalibration of the valve assembly.*

g. Inspect the jet and the nozzle using a flashlight. Place the part on the center of the lens so the light can be seen through the hole. Reclean the part if any particles or coating can be seen.

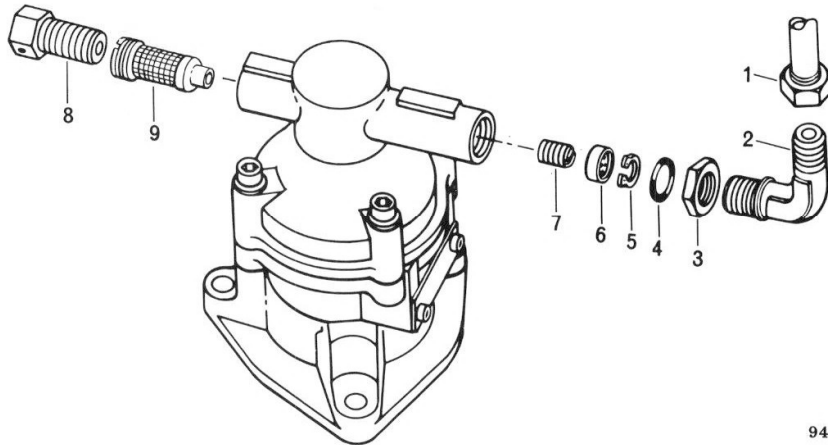
----- CAUTION -----

*Do not use a probe to remove particles lodged in the jet or nozzle.*

h. Install the jet in the bleed valve. Tighten to 8-12 lb in.

i. Place the filter in the bleed valve (skirt end first). Secure with an internal retaining ring.

j. Install the strainer and nozzle in the bleed valve. Tighten to 35-40 lb in. (3.9-5.1 N-m) and secure with lockwire.



1. Air Sensing Tube  
2. Elbow

3. Jam Nut  
4. O-ring

5. Internal Retaining Ring  
6. Filter

9491A

7. Jet  
8. Nozzle  
9. Strainer

Figure 3-26. Bleed Valve Jet and Nozzle Removal

k. Lubricate the O-ring and install it with the elbow on the bleed valve. Do not tighten the elbow jam nut at this time.

l. Position the elbow as required and install the air sensing line. Tighten the coupling nut to 80-120 lb in. Tighten the elbow jam nut to 55-80 lb in.

**3-139. COMPONENT MAINTENANCE.**

3-140. Component maintenance includes inspections, cleaning, replacement and repairs accomplished on the components making up the compressor assembly, the turbine assembly, the combustion section, the power and accessories gearbox and the propeller reduction gearbox.

**3-141. COMPRESSOR.**

3-141A. The cleaning and preservation practices which are necessary for the proper maintenance of the compressor are described in the General Practices paragraphs. (Refer to Compressor, para 3-28A.)

**3-142. Blade and Vane Inspection.** The design of the compressor case permits inspection of blades and vanes by removing the compressor bleed control valve and one compressor half case. (Refer to compressor Case Replacement, para 3-146.) Remove the compressor for overhaul if vane rub marks are found on the hub area of the compressor rotor wheels during the blade and vane inspection. Rework all nicks, dents and corrosion pits by blending.

**NOTE**

Do not remove both case halves at the same time.

**NOTE**

Before reworking any blades, refer to the Blade Damage and Vane Damage, para 3-143 and 3-144.

**3-143. Blade Damage.** Replace the compressor if any blade is cracked or broken off. Recommended corrective actions for compressor blades are as follows:

**NOTE**

It is not possible to fully describe all of the damage conditions that could be incurred; therefore, if damage is within the rework limits of figures 3-27 and 3-28, but there is reasonable doubt about the strength of the reworked blade as compared to a new blade, replace the compressor assembly. Unlimited light polishing to remove minor nicks, where blade dimensions are basically unchanged, is permissible on any part of the blade.

a. General Practices. Blend and polish blades or vanes in a longitudinal direction only with the rework forming a smooth blend with the basic airfoil. The number of blades or vanes which may be reworked is not limited. The limiting factor of blade or vane rework is engine performance. Any reduction of blade or vane area will decrease the efficiency of the compressor and the performance of the engine. Remove as little material as possible. No sharp edges, burrs, cracks or tears are acceptable.

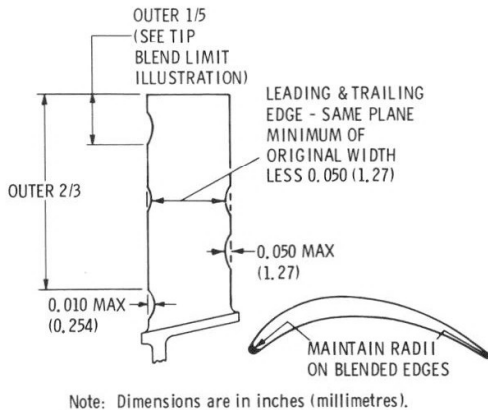
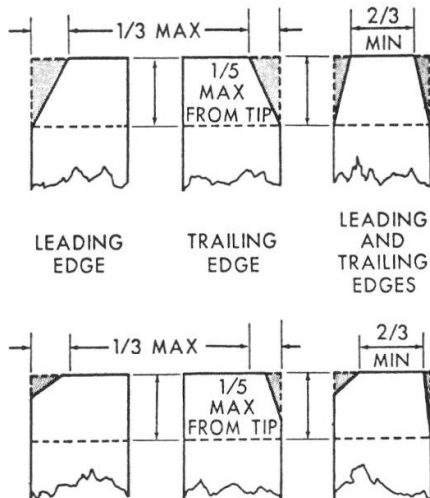


Figure 3-29 deleted.

12338

Figure 3-27. Compressor Rotor Blade Leading and Trailing Edge Blend Limits



768A

Figure 3-28. Compressor Rotor Blade Tip Blend Limits

b. Leading and Trailing Edge Damage. (See figure 3-27.) Blend and polish to remove damage on the outer  $\frac{2}{3}$  of the blade. Replace compressor when: (1) the limits of figure 3-27 are exceeded, or (2) there is edge damage in the lower  $\frac{1}{3}$  that cannot be removed by light polishing.

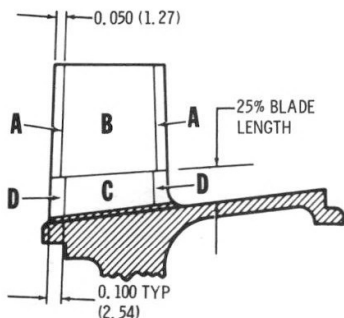
c. Tip damage. (See figure 3-28.) Blend and polish to remove tip damage. Replace compressor when: (1) more than  $\frac{1}{3}$  ( $\frac{1}{6}$  on each side) of the original blade width requires rework or (2) rework extends within the inner  $\frac{4}{5}$  of the blade length.

d. Surface Damage. Blend and polish to remove surface damage. Replace the compressor when any of the limits of figures 3-30 are exceeded.

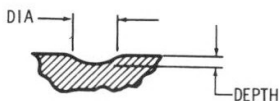
e. Corrosion. Blend and polish to remove all corrosion caused pits by blending to limits defined for damage. Replace the compressor when: (1) pitting in any area of the blade forms a definite line or (2) pit size or location exceeds blend limits.

f. Erosion. Replace the compressor assembly when erosion of a blade tip results in a blade chord width less than the acceptable chord blend limits. (See figure 3-28.)

**3-144. Vane Damage.** Replace the compressor if any vanes are cracked or broken off or show evidence of tip rub on the rotor spacer. Refer to the General Practices in Blade Damage para 3-143 before reworking any vanes. Inspection limits for the vanes are as follows:



**VIEW 1.** DEFINITION OF BLADE AND WHEEL SURFACES



**VIEW 2.** ROUND EDGE, ROUND BOTTOM IMPERFECTIONS

**AREA SURFACE BLENDING LIMIT FOR REMOVAL OF CORROSION PITS, NICKS AND DENTS**

- A** LEADING AND TRAILING EDGE RADII MUST BE MAINTAINED. (SEE LE AND TE BLEND LIMIT ILLUSTRATION FOR REWORK LIMIT.)
- B** 0.020 (0.508) MAX DEPTH; BUT NOT EXCEEDING 1/3 OF BLADE THICKNESS.
- C, D** ON THE CONVEX SIDE OF **C** AND THE CONCAVE SIDE OF **D**, POLISH ONLY. NO MEASUREABLE METAL REMOVAL.
- C, D** ON THE CONCAVE SIDE OF **C** AND THE CONVEX SIDE OF **D**, 0.010 (0.254) MAX DEPTH.

NOTE: ROUND EDGE, ROUND BOTTOM INDENTS (SEE VIEW 2) CAN OCCUR IN THE ORIGINAL AS-CAST SURFACE; THESE ARE NOT CORROSION PITS. IF THE INDENT CANNOT BE WIPED CLEAN (DARK SPOT REMAINS IN INDENT), BLEND THE INDENT AS A CORROSION PIT.

Note: Dimensions are in inches (millimeters).

12339

**Figure 3-30. Compressor Blade Surface Blending Limits.**

**CAUTION**

The compressor cases shall not be immersed in liquids. The case may be set up in a vertical position and sprayed with mineral spirits then immediately blown dry.

a. Vane Repair. Replace compressor case if damage to the vane cannot be blended out without reducing the total width of the vane more than the limits given in figure 3-33. Replace the compressor case when after rework the vane total width is reduced more than the limits given in figure 3-33 or there are sharp edges, burrs, cracks or tears after rework.

b. Surface Damage. (See figure 3-33.) Blend and polish surface damage on the vanes. Replace the compressor case when: (1) the reworked depth exceeds 1/2 of the vane thickness or (2) cracking is detected on the vane surface.

c. Erosion. Replace the compressor case when vane erosion at a specified stage results in a vane chord width less than the acceptable chord width (B). (See figure 3-34.)

d. Corrosion. Blend and polish to remove corrosion pitting. Replace the compressor case when pitting in any

area of the vane forms a definite line or rework exceeds same limits as given for blades. (Refer to figure 3-30.)

**3-145. Case Plastic Coating Inspection.**

a. Acceptable

- (1) Loss of plastic between stator vanes.
- (2) Cracks if there is no evidence of lifting in the blade path.
- (3) Blade rub if there is no evidence of discoloration at the blade tips.
- (4) Erosion of the plastic coating not exceeding one-third (60 degrees) of any single half-case vane band to the degree of exposing the vane band.

b. Unacceptable.

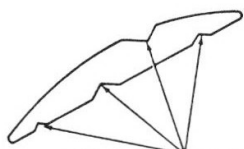
- (1) Missing plastic sections exceeding 3/8 x 1/2 in. (9.5 x 12.7 mm) in the rotor blade path.
- (2) Cracks in the plastic in the rotor path that exhibit evidence of lifting. If lifting is present, removal of loose section is permitted providing the limits of step b. (1) are not exceeded.
- (3) Cracks in the plastic along the horizontal split-line exceeding 3/4-inch (19.1 mm) each, where there is evidence of blade contact.

Figure 3-31 and 3-32 deleted.

**GENERAL**

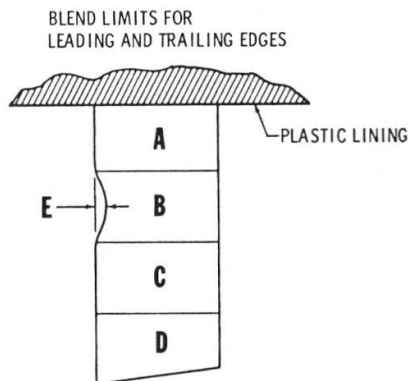
IT IS NOT POSSIBLE TO FULLY DESCRIBE ALL OF THE DAMAGE CONDITIONS THAT COULD BE INCURRED; THEREFORE, IF DAMAGE IS WITHIN THE REWORK LIMITS BUT THERE IS REASONABLE DOUBT ABOUT THE STRENGTH OF THE REWORKED VANES, REPLACE THE COMPRESSOR CASE.

**SURFACE DAMAGE  
NICKS AND DENTS**



AIRFOIL SURFACE NICKS AND DENTS

- OUTER 1/4 OF VANE (RELATED TO CASE AXIS)**  
 MAX DEPTH OF 1/4 AIRFOIL THICKNESS AFTER BLENDING. MAINTAIN 3/64 (1.19) MIN BOTTOM RADIUS OF ALL BLENDING. BLENDS MUST NOT BE IN LINE PARALLEL WITH CASE CENTER LINE AND MUST NOT SHORTEN CHORDAL WIDTH OF VANE.
- INNER 3/4 OF VANE (RELATED TO CASE AXIS)**  
 MAX DEPTH OF 1/2 AIRFOIL THICKNESS AFTER BLENDING. MAINTAIN 3/64 (1.19) MIN BOTTOM RADIUS ON ALL BLENDING. BLENDS MUST NOT BE IN LINE PARALLEL WITH CASE CENTER LINE.



QUARTER	E-MAX
A	0.030 (0.762)*
B-C	0.040 (1.016)
D	0.090 (2.286)

\*STAGES 1, 2, AND 3 MINIMUM CHORDAL WIDTH IN A SHALL BE WITHIN 0.030 (0.762) OF MAX CHORD AT ANY LOCATION ON THE VANE.

Note: Dimensions are in inches (millimetres)

12324

**Figure 3-33. Compressor Stator Vane Blend Limits**

**3-145A. Compressor Front Support Inspection.**

- a. Vanes
- (1) Cracks — none allowed.
  - (2) Dents — max of 0.025 in. (0.635 mm). No punctures allowed.
  - (3) Bulged Vanes — bulges permitted. No cracks allowed.

**3-146. Case Replacement.** Install a new compressor case as follows: (See figure 3-34A.)

----- **CAUTION** -----

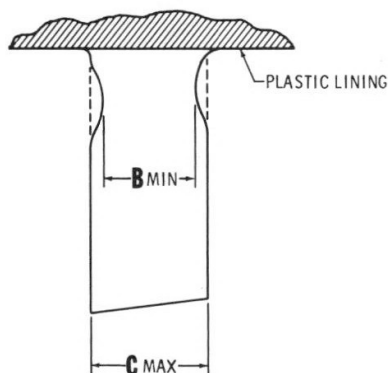
*Do not remove both case halves at the same time.*

----- **NOTE** -----

*Compressor cases are machined in lower and upper matched sets. Rejection and replacement of one case is cause for rejection and replacement of the opposit case (half). Note the serial*

*number on both replacement case halves to assure that the case halves are a matched pair.*

- a. Remove the pressure and scavenge oil lines between the gearbox and the compressor front support.
- b. Remove the RH and LH lines between the anti-ice valve and the compressor front support.
- c. Remove the compressor bleed control valve as follows:
  - (1) Remove the bleed valve compressor discharge pressure sensing line.
  - (2) Remove three nuts, bolts and washers; remove the compressor bleed control valve and gasket.
- d. Remove the top compressor case half (marked "top") as follows:
  - (1) Remove the 17 horizontal split line bolts and nuts.
  - (2) Remove the 5 compressor case-to-compressor front support bolts and nuts.
  - (3) Remove the 8 compressor case-to-compressor front diffuser bolts and nuts.



STAGES 1, 2, AND 3 (B MIN) SHALL NOT BE LESS THAN (C MAX) MINUS 0.030 (0.762).

STAGES 4, 5, AND 6 (B MIN) SHALL NOT BE LESS THAN (C MAX) MINUS 0.060 (1.524).

NOTE: VANES ERODED TO ALLOWED LIMITS CAN RESULT IN SIGNIFICANT REDUCTION IN OVERALL ENGINE PERFORMANCE.

Note: Dimensions are in inches (millimetres)

12322

Figure 3-34. Compressor Vane Erosion

(4) Carefully lift the top case half straight out. If the case does not separate easily, loosen two bolts and nuts at the aft flange and one bolt and nut at the front flange adjacent to each horizontal splitline.

----- NOTE -----

*Note the location of the name plate when the applicable compressor case-to-compressor front support nuts and bolts are removed. Return the nameplate to the same location during reassembly.*

e. Install the new top case half as follows: (Refer to figure 3-35 for location of specific bolts and the numerical sequence in which they should be tightened. The illustration sequence numbers are keyed to like numbers in the text.

----- NOTE -----

*Be sure that the splitline mating flanges are clean before installation of the replacement case half.*

(1) Carefully position the top case half over the rotor. Install a bolt and nut ① in each of the four corner holes (adjacent to the end flanges) at the horizontal flange. Tighten the bolts to the minimum torque necessary to close the horizontal splitlines.

----- NOTE -----

*Tighten all case splitline nuts to 10-15 lb in. (1.13-1.69 N-m) plus locknut drag unless otherwise specified. Locknut drag is the torque necessary to turn the nut on the bolt in the last turn prior to seating of the nut. Lubricate bolts lightly with engine oil before installation.*

(2) Install and tighten two bolts and nuts ② in the rear flange of the top case half. Use the two adjacent bolt holes midway between the horizontal splitlines (approximately 80 degrees from the horizontal flanges). If the bolt holes in the rear flange do not align with the flange holes in the front diffuser, loosen the rear flange bolts in the bottom case half to a snug fit. Using a drift inserted into a misaligned bolt hole, rotate the case sufficiently to align the holes. Tighten the two centermost bolts on the rear flange of the bottom case half; then install and tighten the two centermost bolts and nuts in the rear flange of the top case half.

(3) Loosen the four corner bolts ③ in the horizontal flanges. Allow the horizontal flange to reposition; then retighten the four bolts to the minimum torque necessary to close the horizontal splitlines.

(4) Install the bolts and nuts in the front flange of the top case half at the three centermost bolt hole positions. Tighten the two outer bolts ④ to a snug fit; then tighten the center bolt ⑤. If the bolt holes in the front flange do not align with the flange holes in the front support, loosen the front flange bolts in the bottom case half to a snug fit. Using a drift inserted into a misaligned bolt hole, rotate the front support sufficiently to align the holes. Install and tighten the three bolts and nuts.

f. Remove the bottom case half as follows:

(1) Remove the four bolts and nuts in the horizontal splitlines.

(2) Remove the five bolts and nuts in the bottom case half front flange.

(3) Remove the eight bolts and nuts in the bottom case half rear flange.

(4) Carefully lift the bottom case half straight out. Do not pry against the top case half.

g. Install the new bottom case half as follows:

(1) Apply a sphere of approximately 0.12 in. (3 mm) dia of RTV 731, or equivalent, aft of the rearmost bolt



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hole on the bottom case half horizontal flange surfaces. Assemble and tighten all splitline bolts and nuts as soon as possible after application of RTV 731 (never exceed 30 minutes).

----- **NOTE** -----

*The RTV 731 sealer is used to seal the rear corners of the splitline. Use of the sealer is optional on engines that are not used with the water-alcohol injection system.*

(2) Carefully position the bottom case half over the rotor. Install a bolt and nut (5) in each of the four corners (adjacent to the end flanges) at the horizontal flange. Tighten the bolts to the minimum torque necessary to close the horizontal splitlines.

(3) Install and tighten two bolts and nuts (7) in the rear flange of the bottom case half. Use the bolt holes which are diametrically opposite the top case half bolts.

(4) Loosen the four corner bolts in the horizontal flanges. Allow the horizontal flange to reposition; then retighten the four bolts (8) to the minimum torque necessary to close the horizontal splitlines.

(5) Install and tighten one bolt and nut (9) in the front flange at the center hole position (90 degrees from the horizontal flanges).

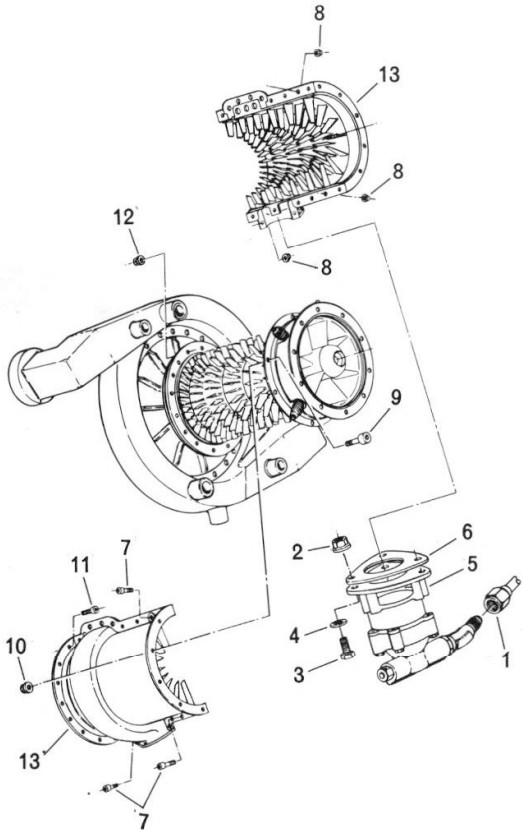
(6) Install the remaining 13 horizontal flange bolts and nuts. Loosen the two rear corner bolts and nuts; then tighten all bolts (10) - (26) starting from the rear and alternating from side to side.

(7) Install and tighten the remaining 12 bolts and nuts (27) in the rear flange and the eight bolts and nuts (28) plus nameplate, in the front flange.

h. Attach the RH and LH anti-icing air tubes to the anti-icing valve and to the front support. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N-m).



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9183A

- |                 |              |                   |
|-----------------|--------------|-------------------|
| 1. Sensing Line | 6. Gasket    | 10. Nut (10)      |
| 2. Nut (3)      | 7. Bolt (16) | 11. Bolt (16)     |
| 3. Bolt (3)     | 8. Nut (16)  | 12. Nut (16)      |
| 4. Washer (3)   | 9. Bolt (10) | 13. Case Half (2) |
| 5. Bleed Valve  |              |                   |

**Figure 3-34A. Compressor Case Removal**

i. Attach the compressor pressure and scavenge oil tubes:

(1) Install the gearbox elbow-to-front support scavenge oil tube. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N-m).

(2) Install the gearbox union-to-pressure reducer pressure oil tube. Tight coupling nuts to 65-100 lb in. (7.34-11.30 N-m).

J. Apply antiseize compound to the bolt threads; then install the bleed control valve and gasket on the compressor case mounting flange. Retain with three nuts, bolts and washers. Tighten the 1/4-28 nut to 70-85 lb in. (7.9-9.6 N-m); tighten the remaining two nuts to 35-40 lb in. (3.9-4.5 N-m). Install the bleed control valve pressure sensing line between the elbows at the valve and the scroll. Tighten coupling nuts to 80-120 lb in. (9.0-13.6 N-m).

k. Turn the compressor rotor using 6799790 engine turning adapter (N, figure 3-1) through the starter-generator pad. Use a wrench to rotate the turning adapter. No blade tip rub (evidenced by feel or noise) is acceptable. Minor touching may be tolerated. As an alternate method, motor the engine with the starter and without ignition to 10-15%  $N_1$  speed. Listen for noise indicating a rub condition caused by case misalignment.

1. Check run the engine after compressor case replacement. (Refer to Check Run, para 3-174.)

**3-164A. Replacing the Compressor Front Bearing and/or Oil Seal (Engine Removed).** This is the preferred procedure for replacing the compressor front bearing or oil seal. Replace these parts with the engine removed from the aircraft and installed in 6795579 turnover stand. To prevent contamination of the  $P_y$  pneumatic line, remove the line from the governor and fuel control before turning the engine to the vertical position. Turn the engine to a vertical position in the stand with the compressor inlet at the top. Replace the seal as follows: (See figure 3-35A.)

----- CAUTION -----

*To prevent assembly difficulties and to minimize possible part damage, do not remove the front support from the compressor unless the engine is in a vertical attitude with the compressor inlet on top.*

- 
- Remove the pressure and scavenge oil lines between the gearbox and the compressor front support.
  - Remove the oil pressure reducer from the compressor front support. Discard O-ring.

----- NOTE -----

*Any time the compressor front bearing and/or front bearing oil seal is replaced or the oil system has been contaminated, disassemble and inspect the oil pressure reducer.*

(1) Remove the internal retaining ring; then separate the restrictor from the oil pressure reducer body. (See figure 3-35A.)

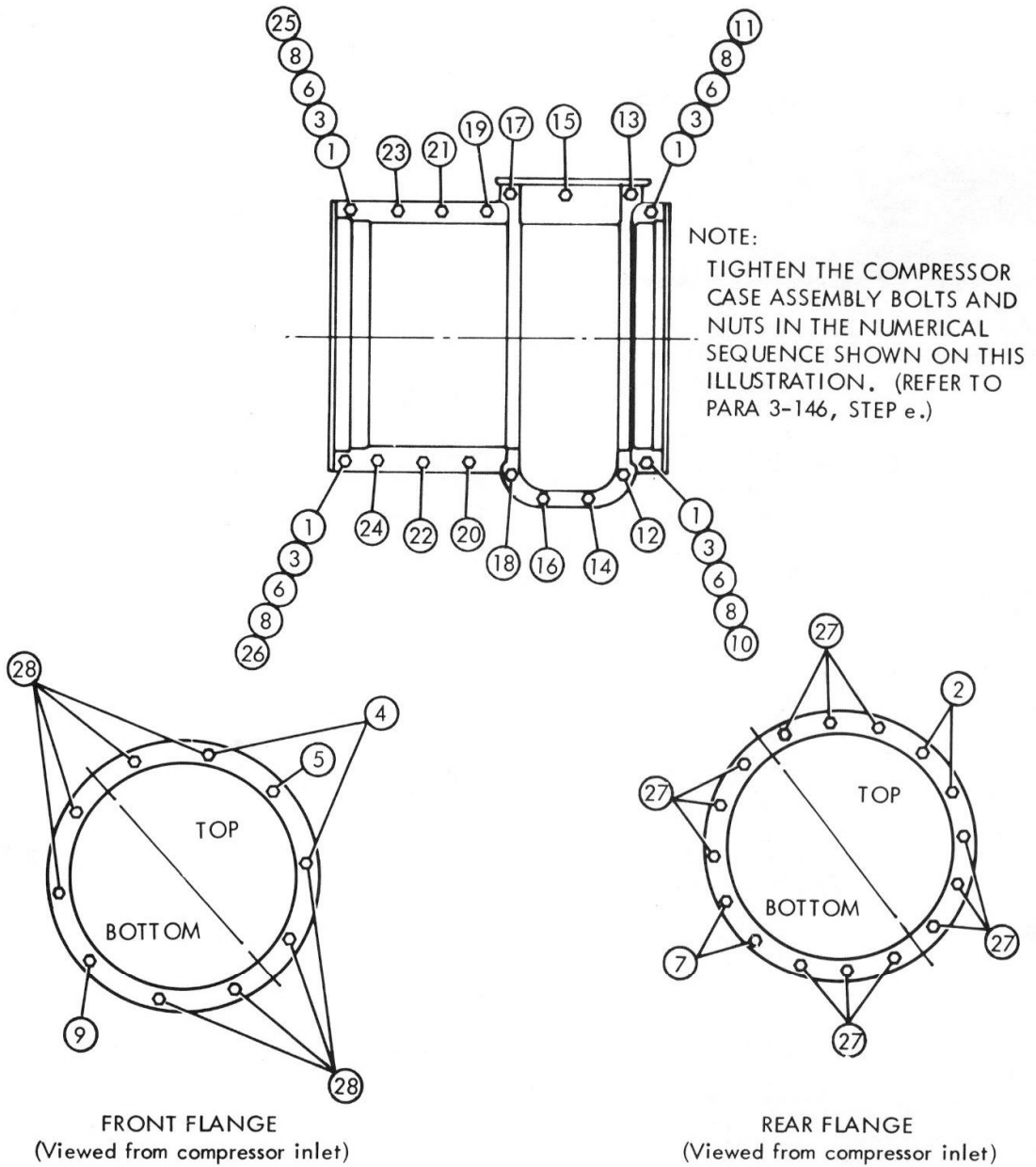
(2) Clean all debris from the restrictor and the body using mineral spirits and a soft bristle brush.

(3) Inspect the restrictor for burrs and/or damage to the lands. Replace restrictor if either condition exists.

(4) Reassemble the oil pressure reducer by installing the restrictor threaded end first into the body. (See figure 3-35A.) Secure with the internal retaining ring. Be sure the retaining ring is properly seated in the groove in the body.

(5) Lubricate a new O-ring and install it with the oil pressure reducer in the compressor front support. Tighten to 50-75 lb in. (5.6-8.5 N-m).

c. Remove the RH and LH lines between the anti-ice valve and the compressor front support.



16760

Figure 3-35. Compressor Case Installation  
Bolt Tightening Sequence



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- d. Remove the starter-generator.
- e. Remove the P<sub>c</sub> air line between the bleed valve and the scroll.
- f. Remove three nuts, bolts and washers and separate the bleed control valve and gasket from the mounting flange on the compressor case.
- g. Remove the compressor front support nut. Remove 10 bolts and nuts at the front support flange.
- h. Loosen, but do not remove, the compressor case splitline nuts and bolts.
- i. Separate the compressor front support from the compressor assembly. Discard two O-rings. The identification plate is removed by this operation.
- j. Release the internal retaining ring using 6893535 compressor and separate the compressor front bearing housing from the rotor assembly. Discard O-ring. If alternate configuration is used, separate front bearing housing by pulling the two spring pins.
- k. Remove the helical spring and spring cup from the rotor.

l. If it is necessary to replace or reseal the bearing damper in the front bearing housing, remove the damper using 6799700 puller. (See figure 3-35B.)

m. Remove the bearing retaining nut using a standard socket wrench. Hold the rotor from turning using 6799790 adapter in the starter-generator pad on the gearbox cover.

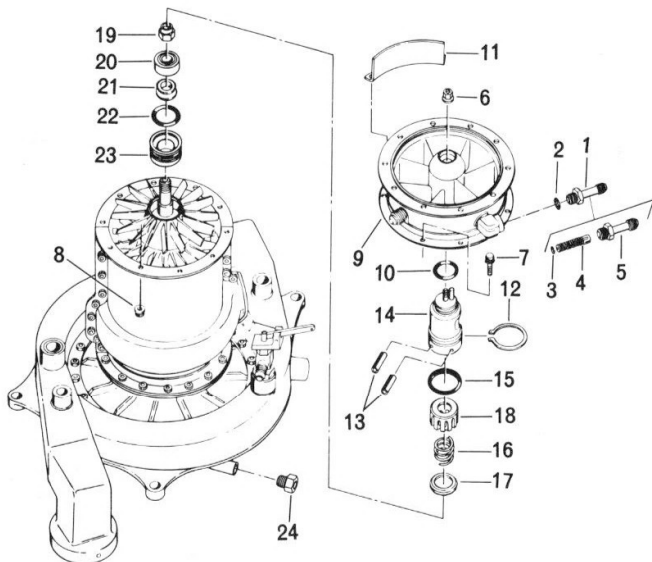
----- CAUTION -----

*Do not hold or turn the N<sub>1</sub> gear train through the spare drive pad. This could result in damage to the gearbox.*

*Exercise care when removing the compressor bearing nut. Do not allow the nut wrench to contact the bearing.*

-----

n. To remove the compressor front ball bearing and seal mating ring, pull at the mating ring puller groove using 6796952 puller. (See figure 3-35C.) The bearing and seal mating ring come off together.



12595C

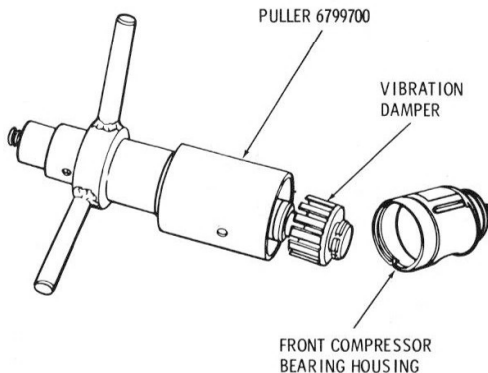
- |                            |                           |
|----------------------------|---------------------------|
| 1. Oil Pressure Reducer    | 13. Pin (2)               |
| 2. O-ring                  | 14. Front Bearing Housing |
| 3. Internal Retaining Ring | 15. O-ring                |
| 4. Restrictor              | 16. Spring                |
| 5. Body                    | 17. Spring Cup            |
| 6. Nut                     | 18. Vibration Damper      |
| 7. Bolt (10)               | 19. Nut                   |
| 8. Nut (10)                | 20. Ball Bearing (No. 1)  |
| 9. Front Support           | 21. Seal Mating Ring      |
| 10. O-ring                 | 22. O-ring                |
| 11. Identification Plate   | 23. Oil Seal              |
| 12. Retaining Ring         | 24. Diffuser Vent Orifice |

Figure 3-35A. Compressor Front Bearing and Oil Seal Replacement

----- CAUTION -----

*The compressor front bearing can be damaged easily. Do not pull on the bearing; pull on mating ring. Replace bearing if at any time during removal or installation the bearing is dropped, loaded through the balls to the inner race or the outer race is pulled off.*

- o. Remove the oil seal from the rotor. Discard O-ring.
- p. If the vibration damper was removed, install the replacement damper or reseal the old damper as follows:
  - (1) Install the vibration damper on 6798796 drift. Chill the damper and the drift using dry ice. As an option, the bearing housing may be heated to 250°F (121°C) maximum.
  - (2) Press the damper into the front bearing housing until it bottoms out against the shoulder of the bearing housing. Apply constant pressure to the drift until such time the temperature of the damper and the housing have equalized. Remove the drift.
  - (3) Measure the installed position of the damper. The inside of the damper flange should be 1.218 in. (30.94 mm) minimum from the housing open end.
- q. Lubricate inside the replacement seal with engine oil (by soaking). Install lubricated O-ring on the seal; then install the seal on the rotor.
- r. Install the seal mating ring (pulling lip forward) and the bearing (wire clip forward) on the compressor rotor. Secure with a nut. Tighten nut to 70-90 lb in. (7.9-9.0 N-m) above torque due to locknut drag. Hold the rotor from turning using 6799790 adapter in the starter-generator pad on the gearbox cover.



4004C

**Figure 3-35B. Pulling the Compressor Front Bearing Vibration Damper**

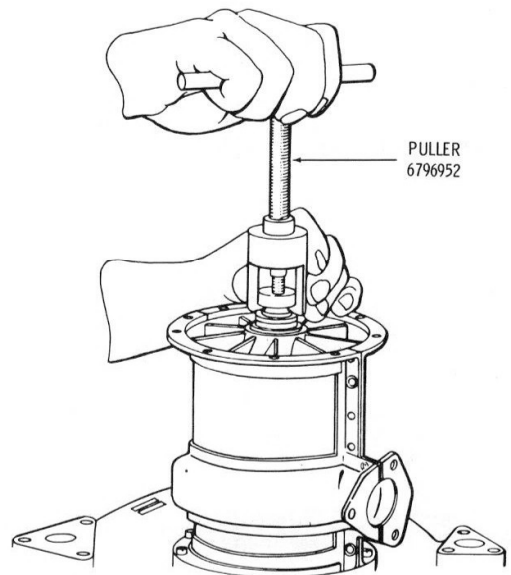
----- CAUTION -----

*Exercise care when installing the nut. Do not allow the wrench to contact the bearing.*

- s. Install the spring and spring cup. The cup sleeve fits over the spring on the end that contacts the bearing.
- t. Install the retaining ring in the rear groove of the oil seal. Install the front bearing housing over the spring, bearing and oil seal. Compress the retaining ring in the seal groove and engage the ring in the inside groove of the bearing housing until it is fully seated using 6893535 compressor. Exercise care not to damage the seal face. On alternate configuration, press down (rearward) on the housing until the two pin holes of the housing align with the retaining ring groove of the seal. Insert the two pins. Lubricate and install two O-rings on the bearing housing.

----- CAUTION -----

*Do not force the support flange into the compressor case pilot - loosen the compressor case horizontal splitline bolts as necessary for ease of assembly, even to the point of removing one case half.*



9347

**Figure 3-35C. Removing Compressor Front Bearing and Seal Mating Ring**



u. Visually align the pin of the bearing housing with the hole in the compressor front support then install the front support on the compressor assembly. This part is indexed correctly when the scavenge oil fitting is opposite the "O" mark on the front diffuser. Lubricate the threads of the front bearing housing with antiseize compound. Secure housing to the front support with a nut. Tighten nut to 35-40 lb in. (3.9-4.5 N-m). Install the identification plate and ten support-to-compressor case bolts and nuts. Tighten the compressor horizontal splitline and front support splitline nuts to 10-15 lb in. (1.1-1.7 N-m) plus locknut drag.

v. Apply antiseize compound to the bolt threads; then install the bleed control valve and gasket on the compressor case mounting flange. Retain with three nuts, bolts and washers. Tighten the 1/4-28 nut to 70-85 lb in. (7.9-9.6 N-m). Tighten the other two nuts to 35-40 lb in. (3.9-4.5 N-m).

w. Attach the compressor discharge pressure sensing tube assembly to the bleed valve and to the elbow at the scroll. Tighten coupling nuts to 80-120 lb in. (9.0-13.6 N-m).

x. Attach the RH and LH anti-icing air tubes to the anti-icing valve and to the front support. Tighten coupling nuts to 150-200 lb in. (17.23 N-m).

y. Check the oil seal for leakage by applying oil at 4-6 psi (27.6-41.4 kPa) for one minute to the oil pressure reducer location on the compressor front support. No leakage shall be permitted.

z. Attach the compressor pressure and scavenge oil tubes:

(1) Install the gearbox elbow-to-front support scavenge oil tube. Tighten coupling nuts to 150-200 lb in. (17-23 N-m).

(2) Install the gearbox union-to-pressure reducer pressure oil tube. Tighten coupling nuts to 65-100 lb in. (7.3-11.3 N-m).

(3) Using mineral spirits, clean inside the  $P_y$  pneumatic line. Shake then air dry.

(4) Install the  $P_y$  line between the governor and the fuel control. Tighten coupling nuts to 80-120 lb in. (9.0-13.6 N-m).

aa. Install the starter-generator.

ab. After complete assembly of the compressor, check the compressor rotor for freedom of operation. If compressor drag or rubbing is detected either by feel or by sound, investigate to determine the cause by removing one or both halves of the case assembly. (Refer to para 3-146.)

ac. Check run the engine after seal or bearing replacement. (Refer to Check Run, para 3-174.)

**3-146B. Replacing the Compressor Front Bearing and/or Oil Seal (Engine Installed).** This is an alternate procedure for replacing the front bearing and/or oil seal while the engine is installed and in a horizontal position.

----- CAUTION -----

*This alternate procedure involves greater risk of part damage and assembly error than the preferred procedure (para 3-146A). The alternate procedure is recommended only for skilled mechanics having approval of their Distributor.*

a. Support the compressor rotor in the compressor case by carefully installing shim stock between the first-stage wheel blade tips and the case halves. Install the shim stock through the open end of the compressor front support at three equally spaced locations.

----- CAUTION -----

*In order to ensure that removal of the shim stock is not overlooked at reassembly, it is suggested that a string or streamer be attached to the protruding end of the shim stock before the stock is inserted into the compressor.*

b. Replace the compressor front bearing and/or oil seal in the same manner as used in Engine Removed (steps a. through ab. of para 3-146A).

c. Remove the shims from between the first-stage wheel blade tips and the case halves.

d. Check run the engine. (Refer to Check Run, para 3-174.)

**3-147. Replacing the Compressor Assembly.** Replace the compressor assembly as follows: (Refer to figure 3-36.)

a. Remove the tee-to-front support pressure oil tube.

b. Detach the clamp and remove the gearbox-to-tee pressure oil tube.

c. Detach the clamp and remove the front support-to-gearbox scavenge oil tube.

d. Remove the clamp from the left side anti-icing tube. Remove the two anti-icing tubes.

e. Remove the scroll-to-bleed valve pressure sensing air line.

f. Remove the scroll-to- $P_c$  filter pressure sensing air line.

g. Disconnect the  $P_c$  filter-to-fuel control pressure sensing air tube at the  $P_c$  filter.



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h. Remove the three bolts, nuts, and washers and separate the bleed control valve from the compressor. Discard the gasket.

i. Remove the anti-icing air valve from the compressor. Discard O-ring.

j. Remove the two pressure probe elbows from the compressor scroll. Discard O-rings.

k. Deleted

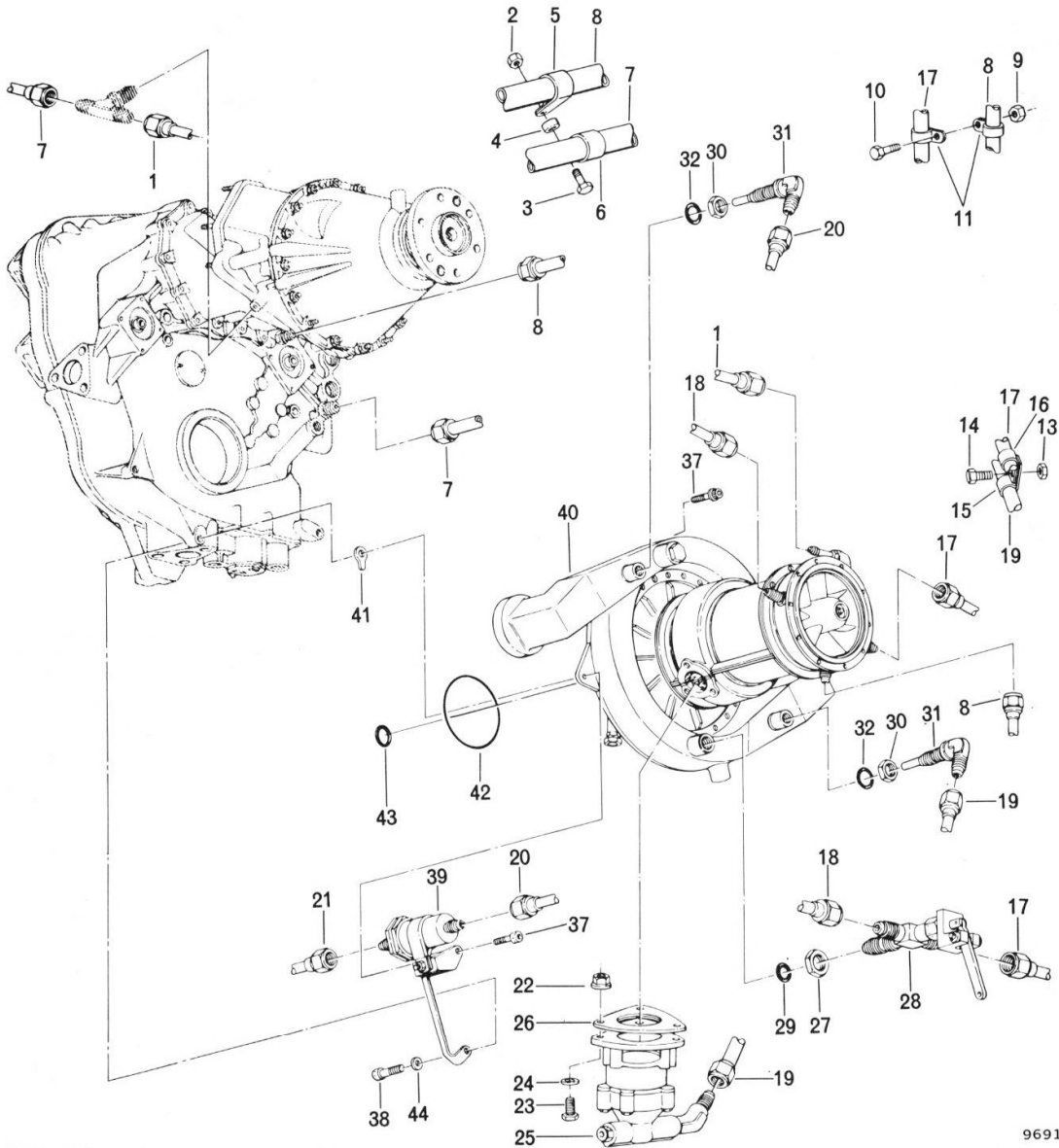
l. Remove the two bolts securing the P<sub>c</sub> filter bracket to the engine. Remove the filter and bracket assembly.

m. Remove the turbine assembly from the engine. (Refer to the applicable part of Replacing the Turbine Assembly, para 3-158.)

n. Lubricate (engine oil) the spur adapter gearshaft bearing guide 6872646 and install it on the compressor spur adapter gearshaft. (See figure 3-37.)



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9691C

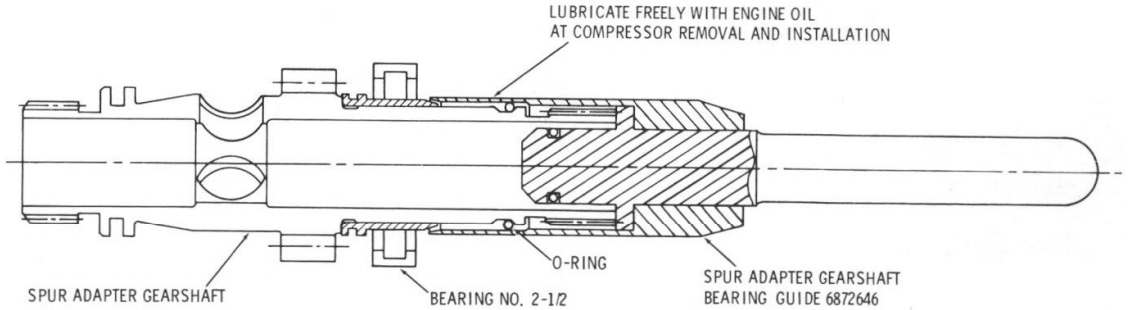
- 1. Tee-to-Front Support Pressure Oil Tube
- 2. Nut
- 3. Bolt
- 4. Bushing
- 5. Clamp
- 6. Clamp
- 7. Gearbox-to-Tee Pressure Oil Tube
- 8. Front Support-to-Gearbox Scavange Oil Tube
- 9. Nut

- 10. Bolt
- 11. Clamp (2)
- 12. Deleted
- 13. Nut
- 14. Bolt
- 15. Clamp
- 16. Clamp
- 17. LH Anti-icing Tube
- 18. RH Anti-icing Tube
- 19. Scroll-to-Bleed Valve Sensing Tube
- 20. Scroll-to-P<sub>c</sub> Filter Sensing Tube

- 21. P<sub>c</sub> Filter-to-Control Sensing Tube
- 22. Nut (3)
- 23. Bolt (3)
- 24. Washer (3)
- 25. Bleed Control Valve
- 26. Gasket
- 27. Nut
- 28. Anti-icing Valve
- 29. O-ring
- 30. Nut (2)
- 31. Pressure Probe Elbow (2)
- 32. O-ring (2)

- 33. Deleted
- 34. Deleted
- 35. Deleted
- 36. Deleted
- 37. Bolt (4)
- 38. Bolt
- 39. P<sub>c</sub> Filter-Bracket Assembly
- 40. Compressor Assembly
- 41. Shim
- 42. O-ring
- 43. O-ring
- 44. Washer

Figure 3-36. Replacing the Compressor Assembly



9602B

**Figure 3-37. Bearing Guide Installed on Spur Adapter Gearshaft**

o. Remove the remaining three compressor mounting bolts and separate the compressor assembly from the gearbox. Save the shims found at the compressor mounting pads for possible reuse. Remove bearing guide 6872646 from the spur adapter gearshaft. Discard O-rings.

p. Make the following inspection of the compressor discharge air tube seal groove lands and split seal rings at the compressor (small) end.

(1) Remove the split seal rings from the small end of the air tubes.

(2) Replace the split seal rings if the edges show wear which could be detrimental to the sealing effect or if the expander ring is broken.

(3) Inspect discharge air tube lands in accordance with figure 3-46C.

(4) Apply antiseize compound to the components of the split seal rings. Install the rings on the discharge air tubes. Split seal ring gaps should be 180° apart.

q. Make the following inspection of the turbine to compressor coupling splines.

(1) Run (or scribe) a suitable pointed object across the spline surfaces at both coupling ends to check for a wear step.

(2) Reject the coupling if the pointed object catches on the wear step. Polished spline surfaces are acceptable. If there is any doubt on the depth of the wear step, reject the coupling.

3-148. Install the replacement compressor as follows: (See figure 3-36.)

----- **NOTE** -----

*Check to ensure that the compressor and gearbox mounting flanges are clean and free of foreign material which could cause misalignment.*

*Check that the spur adapter gearshaft retaining ring is properly installed.*

-----

a. Lubricate and install new O-rings on the rear diffuser and on the spur adapter gearshaft.

b. Lubricate (engine oil) the bearing guide 6872646 and install it on the spur adapter gearshaft (See figure 3-37.)

c. Sparingly lubricate the rollers of the No. 2-½ bearing with petrolatum to hold the rollers out against the bearing outer race.

d. Determine the number of shims required for compressor installation. The number of 0.002 in. (0.05 mm) thick shims required at each bolt hole is marked on the rear diffuser adjacent to the hole (1 requires one 0.002 in. (0.05 mm) shim; 2 requires two 0.002 in. (0.05 mm) shims, etc). Place the compressor on the gearbox with the required shims in place at the bolt pads. Install the P<sub>c</sub> filter and bracket at the bottom and lower right compressor mounting bosses. Attach the compressor with five bolts and one washer. Tighten bolts to 70-85 lb. in. (7.9-9.60 N·m) and secure with lockwire.

e. Remove bearing guide 6872646 from the spur adapter gearshaft. Visually check that the spur adapter gearshaft O-ring is in place.

f. Install the turbine assembly. (Refer to the applicable part of Replacing the Turbine Assembly, para 3-158.)

g. Deleted

h. Install the anti-icing valve on the diffuser scroll. Do not tighten jam nut at this time. (Refer to Anti-Icing Air System, para 3-131.)

i. Install the right and left side anti-icing air tubes. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N·m). Tighten anti-icing valve jam nut to 100-150 lb in. (11.30-16.95 N·m) and secure with lockwire.



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j. Install bleed control valve and gasket on the compressor. Retain with three nuts, bolts, and washers. The 1/4-28 bolt goes in the top hole, tighten this nut to 70-85 lb in. Tighten the two 10-32 nuts to 35-40 lb in.

k. Apply antiseize compound lightly to the threads of the two pressure probe elbows. Install the elbows with new O-rings in the diffuser scroll. Do not tighten the jam nuts until final tube alignment is made.

l. Install pressure sensing tube between bleed valve and pressure probe elbow. Tighten coupling nuts to 80-120 lb in. Tighten elbow jam nuts to 55-80 lb in. and secure with lockwire.

m. Install pressure sensing tube between the P<sub>c</sub> filter and pressure probe elbow. Connect tube to aft end of P<sub>c</sub> filter. Tighten coupling nuts to 80-120 lb in. Tighten elbow jam nut to 55-80 lb in. and lockwire.

n. Install the compressor oil supply and scavenge lines.

(1) Gearbox-to-tee pressure oil tube. Tighten couplings to 65-100 lb in.

(2) Tee-to-front support pressure oil tube. Tighten couplings to 65-100 lb in.

(3) Compressor-to-gearbox scavenge oil tube. Tighten couplings to 150-200 lb in.

o. Install tube clamps as shown in figure 3-36. Tighten clamp nuts to 35-40 lb in.

p. Make appropriate entry relative to compressor replacement in the Engine Log.

q. Check run the engine after compressor replacement. (Refer to Check Run, para 3-174.)

3-149. TURBINE.

----- WARNING -----

*An engine which has been operated on leaded fuel has a pale yellow powder residue on the exhaust passages. Handling lead residue coated parts by persons with open cuts or scratches on their hands can be extremely dangerous. Always wear gloves when handling residue coated parts.*

3-150. **Blade and Vane Inspection.** Inspect the first-stage turbine blades and vanes with the combustion section removed. (Refer to Replacing the Combustion Liner, para 3-162.) Inspect the fourth-stage turbine blades through the exhaust ducts.

3-151. **Blade Damage.** Replace the turbine assembly if any of the following conditions exist:

- a. Damage to inner 1/3 of blade.
- b. Blade or stator vane broken off.
- c. Cracked blade.
- d. Melted vane or blade.

3-152. **First-Stage Turbine Nozzle and Nozzle Shield.**

The inspection limits and disposition regarding specific conditions which may be encountered are given in table III-8. The limits given in the table are defined as follows:

a. Serviceable limits is the maximum degree of a specified condition which can be accepted, allowing the part to be placed back into service without repair.

b. Repairable limit is the maximum degree of a specified condition which can be repaired. Any condition exceeding the limit cannot be corrected by the specified repair procedure; therefore, the part must be condemned.

TABLE III-8

First-stage Turbine Nozzle and Nozzle Shield Inspection

Item	Condition	Serviceable Limit	Repairable Limit	Disposition
<b>First-Stage Nozzle</b>				
1	Axial cracks in vane airfoil.	Leading edge 1/4 in. max; trailing edge 5/16 in. max. a. No two cracks in same plane. b. Adjacent cracks 1/4 in. apart. c. Adjacent cracks not progressing toward each other.	Leading edge 3/8 in. max; trailing edge 3/8 in. max.	Gas tungsten-arc weld repair using L-605 (AMS 5796) or alternate Hastelloy X (AMS5798) Anneal at 1950± 25°F for one hour. Rapid air cool. Restore to original contour by grinding with fine grit stone.



TABLE III-8 (cont)

Item	Condition	Serviceable Limit	Repairable Limit	Disposition
2	Nicked or dented leading and trailing edge. Warped or burned trailing edge only.	Leading edge $\frac{1}{16}$ in. max; trailing edge $\frac{1}{8}$ in. max.	Leading edge $\frac{3}{32}$ in. max; trailing edge $\frac{5}{32}$ in. max. Max of three adjacent vanes and total of eight vanes.	Repair by blending with fine grit stone.
			Leading edge $\frac{1}{8}$ in. max; trailing edge $\frac{1}{4}$ in. max.	Weld repair and restore to original contour by grinding with fine grit stone.
3	Fillet cracks—inner and outer band.	Leading edge $\frac{1}{4}$ in. max; trailing edge $\frac{1}{8}$ in. max.	Leading edge $\frac{3}{8}$ in. max; trailing edge $\frac{3}{16}$ in. max.	Weld repair as in Item 1.
4	Inner band.	Leading edge $\frac{3}{16}$ in. max axially into the band and not in line with trailing edge cracks. Trailing edge—extending through inner band to sheet metal detail.	Leading edge $\frac{3}{8}$ in. max axially. Trailing edge extending through inner band to sheet metal detail.	Weld repair as in Item 1.
5	Outer band leading and trailing edges.	Extending $\frac{3}{16}$ in. axially into the band and not in line with crack on opposite edge.	Extending $\frac{1}{2}$ in. axially into the band and not in line with crack on opposite edge.	Weld repair as in Item 1.
6	Sheet metal diaphragm.	Extending $\frac{1}{2}$ in. circumferentially, max of two cracks at least two in. apart.	None.	Replace nozzle.
<b>First-Stage Nozzle Shield</b>				
7	Cracks around spotwelds on heat shield.	Cracks are acceptable provided the length of the crack is not greater than 50% of the distance around the weld.	Up to 100% cracking in all welds.	Inert gas weld using filler material class 13.

**3-153. Replacing the First-stage Turbine Nozzle or First-stage Turbine Nozzle Shield.** Replace the first-stage turbine nozzle shield using the applicable part of the following first-stage turbine nozzle replacement procedure.

a. Remove the turbine and install it in the supporting adapter (M, figure 3-1). Attach at the three exhaust collector support bolt holes with the gas producer support up. (Refer to Replacing the Turbine Assembly, para 3-158.)

----- **NOTE** -----

*It may be necessary to reverse the three turbine attaching studs on the supporting adapter plate from an under side mounting position to a top side mounting position.*

-----

b. Clamp holding wrench (J, figure 3-1) on the supporting adapter. The wrench fits through the power turbine drive and on the gas producer turbine rotor drive spline. The wrench is secured by two handknobs.

c. Remove the four bolts securing the gas producer and power turbine pressure oil manifold. Remove the manifold and discard the two O-rings. (See figure 3-38.)

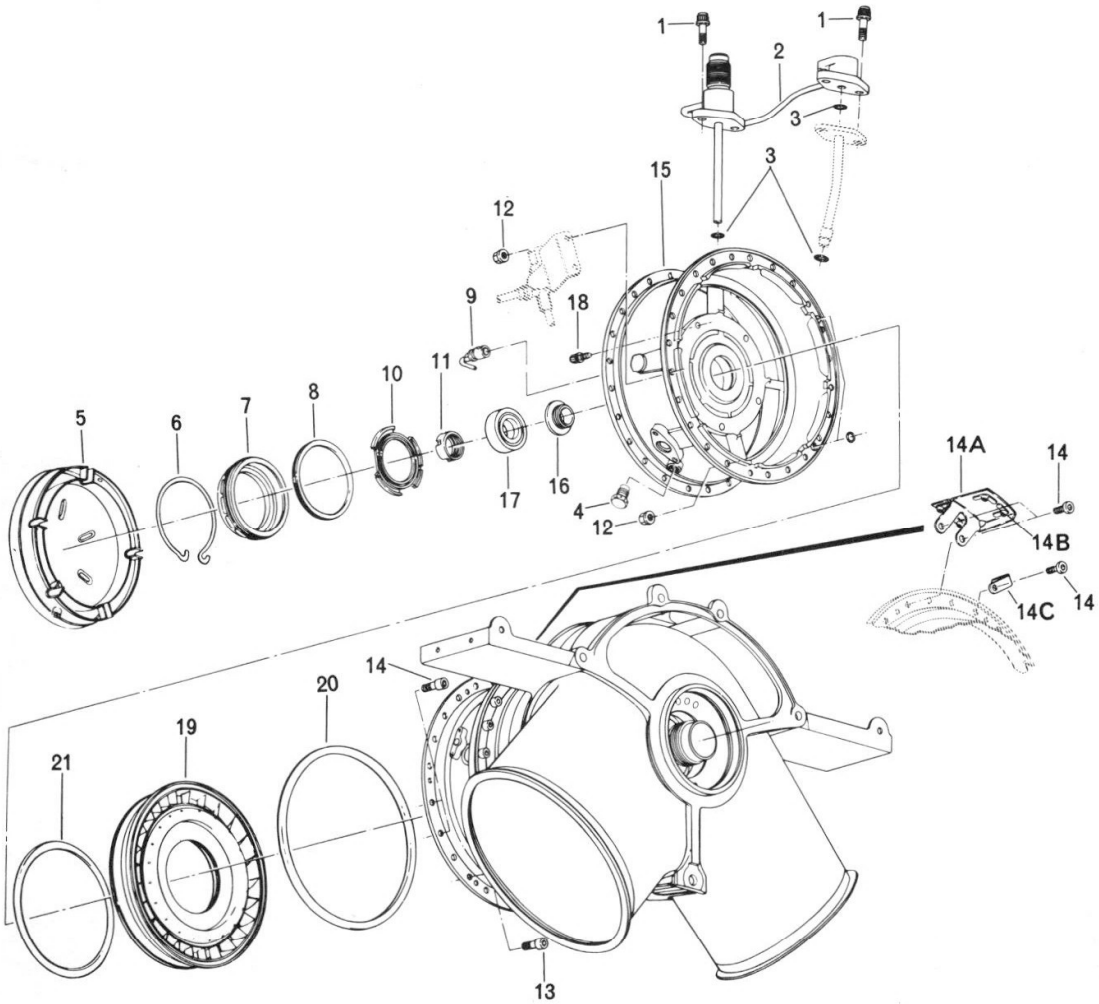
d. Remove the two positioning plugs and separate the first-stage turbine nozzle shield from the turbine.

e. Remove G-type retaining ring.

f. Remove the gas producer turbine sump and nut assembly using the sump wrench (L, figure 3-1.)

g. Remove and discard metallic U-ring gasket.

h. Remove the gas producer turbine bearing oil nozzle using the puller (F, figure 3-1.)



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- |                                      |                                    |                                    |
|--------------------------------------|------------------------------------|------------------------------------|
| 1. Bolt (4)                          | 9. Gas Producer Bearing Oil Nozzle | 14C. Angle Bracket                 |
| 2. Pressure Oil Manifold             | 10. Bearing Retaining Plate        | 15. Gas Producer Turbine Support   |
| 3. O-ring (3)                        | 11. Spanner Nut                    | 16. Rotating Labyrinth Seal        |
| 4. Positioning Plug (2)              | 12. Nuts (24)                      | 17. Bearing                        |
| 5. First-stage Turbine Nozzle Shield | 13. Bolts (19)                     | 18. Bolts (5)                      |
| 6. G-type Retaining Ring             | 14. Bolts (5)                      | 19. First-stage Turbine Nozzle     |
| 7. Sump and Nut Assembly             | 14A. Bracket                       | 20. Fiberglass Packing (20,25 in.) |
| 8. Metallic U-ring Gasket            | 14B. Nut (4)                       | 21. Fiberglass Packing (11,12 in.) |

Figure 3-38. First-stage Nozzle Replacement



- i. Remove bearing retaining plate.
- j. Remove the spanner nut using 6798046 bearing locknut wrench (K, figure 3-1.) (This nut has a left-hand thread.)
- k. Remove the No. 8 bearing and then the rotating labyrinth seal using 6795590 puller (B, figure 3-1).
- l. Remove the 24 nuts and bolts from the splitline; then lift the gas producer turbine support from the turbine. The thermocouple assembly bracket is detached during this step. On recent configurations, the bracket which supports the coordinator bracket and an angle bracket for support of the manifold clamp are also removed.

----- **NOTE** -----

*The second-stage nozzle tang is match marked opposite the small hole on the power turbine and gas producer support flanges. If this marking is not visible, remark it immediately after the gas producer turbine support is removed, before the gas producer turbine rotor has been moved in any manner.*

- m. Remove lockwire and five bolts at the rear of the gas producer turbine support; remove the first-stage turbine nozzle. Discard fiberglass packing.
- n. Flush the oil passage in the gas producer support with mineral spirits.

3-154. Install the first-stage turbine nozzle as follows: (See figure 3-38.)

- a. Place preformed fiberglass packing in the inner flange of the first-stage turbine nozzle. Install the first-stage turbine nozzle in the gas producer turbine support. Retain with five bolts; coat bolt threads lightly with antiseize compound before installation. Tighten bolts to 30-40 lb in. and secure with lockwire.
- b. With the turbine installed in 6798089 supporting adapter (M, figure 3-1) and with the rotor retained by 6798045 holding wrench (J, figure 3-1), position the index mark on the tang of the second stage nozzle in alignment with the small hole in the power turbine support flange. Place preformed fiberglass packing in the first-stage turbine nozzle then install the gas producer turbine support on the turbine. The power turbine and gas producer turbine supports are properly indexed when the balance piston air tubes are aligned. When the gas producer turbine support is properly seated in the tang slots retain it with 24 bolts and nuts. Coat bolt threads lightly with antiseize compound before installation. The half-inch (12.7 mm) bolts go at positions 8, 9, 21, 23 and 24 counting clockwise with 1 at top center when looking forward. The thermocouple assembly bracket is retained on the aft side of this splitline at bolt positions 8 and 9. On recent configurations the bracket which supports the coordinator bracket and an angle bracket for support of the manifold clamp are retained on the forward side of the splitline at bolt positions 23, 24 and 21 respectively. Tighten nuts of socket

head cap screw to 20-30 lb in. (2.26-3.39 N-m). Tighten nuts of Tee-head bolts to 35-40 lb in. (3.95-4.52 N-m).

- c. Lubricate (engine oil) and install the rotating labyrinth seal and the gas producer turbine ball bearing, using 6895538 press (T, figure 3-1 with detail -7).

----- **NOTE** -----

*Install the bearing in the position noted at disassembly.*

- d. Lubricate (engine oil) and install the spanner nut using 6798046 bearing locknut wrench (K, figure 3-1). Tighten nut (left-hand thread) to 150-175 lb in. (16.95-19.77 N-m) and stake nut edge into lock detent using 6798926 crimper.

- e. Lubricate two new O-rings and install the gas producer and power turbine pressure oil manifold. Apply a light coat of antiseize compound to the threads and install the four retaining bolts. Tighten to 35-40 lb in. (3.95-4.52 N-m) and lockwire. Blow through the installed manifold with clean compressed air to ensure that it is clear.

- f. Position the bearing retaining plate against the bearing. Use the pin in the support and the small slot in the plate for index location.

----- **CAUTION** -----

*Failure to properly index the bearing retaining plate may result in an internal engine fire caused by oil leaking past the No. 8 bearing labyrinth seal.*

- g. Install the gas producer bearing oil nozzle using 6796920 puller (F, figure 3-1). Be sure the anti-rotation pin aligns with the index slot of the oil nozzle. If the pin does not engage the slot of the nozzle, stake the pin into the slot in such a manner that the nozzle can be removed without removal of the pin. Replace pin having cracks or tears in the staked surface. Target the nozzle.

- h. Carefully coat the threads of the sump and nut assembly with antiseize compound. Lubricate and position the metallic U-ring gasket with the rolled edge adjacent to the sump. Install the sump and nut assembly using 6798047 sump wrench (L, figure 3-1). Tighten to 100-110 lb ft. (11.30-12.43 N-m).

- i. Install the G-type retaining ring.
- j. Install the first-stage turbine nozzle shield on the turbine. Retain with two positioning plugs. Coat threads of plugs lightly with antiseize compound before installation. Tighten positioning plugs to 100-120 lb in. (11-13 N-m) and secure with lockwire.
- k. Remove the turbine from the supporting adapter.
- l. Install the turbine on the engine assembly. (Refer to Replacing the Turbine Assembly, para 3-158.)
- m. Check run the engine after turbine replacement. (Refer to Check Run, para 3-174.)



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**3-155. Turbine and Exhaust Collector Support Crack Repair.** Weld repair any cracks found in the exhaust ducts or outboard structure of the turbine and exhaust collector support.

----- **CAUTION** -----

*To prevent electrical arc bearing damage, separate the exhaust collector from the engine/turbine and remove the No. 5 bearing before the weld repair is made.*

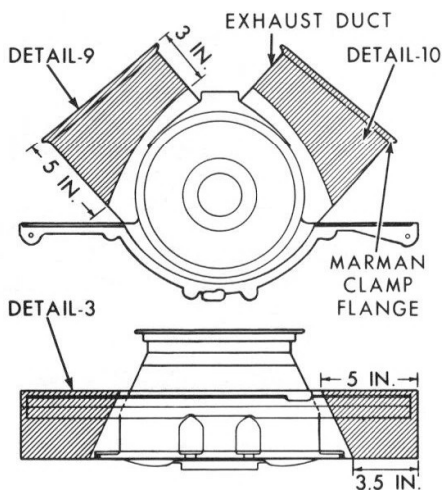
- a. Weld cracks in the exhaust ducts (areas-9 and -10 of figure 3-39) using gas tungsten-arc process with 29-9 W Mo (AMS 5784) weld rod.
- b. Weld cracks in the-outboard structure (area -3 of figure 3-39) using gas tungsten-arc process with Hastelloy W (MIL-R-5031, class 12) weld rod.

**3-156. Removal of the Oil Bellows Seal.** Remove the oil bellows seal as follows: (See figure 3-40.)

- a. Remove the turbine and combustion section as a unit. (Refer to the applicable portions of Replacing the Turbine Assembly, para 3-158.)
- b. Attach the turbine and combustion section assembly on 6798089 supporting adapter (M, figure 3-1), at the three exhaust collector support bolt holes, with the combustion section down.

----- **NOTE** -----

*It may be necessary to reverse the three turbine attaching studs on the supporting adapter plate from a top side mounting position to an under side mounting position.*



**Figure 3-39. Weld Repairable Areas of the Turbine and Exhaust Collector Support**

8516

- c. Remove the power turbine shaft ball bearing spanner nut using 6795984 holder and 6795985 wrench (C, D, figure 3-1).
- d. Remove the internal retaining ring and spacers (washer) from the turbine and exhaust collector support.
- e. Pull the ball bearing from the power turbine shaft with 6795590 puller (B, figure 3-1).

----- **NOTE** -----

*Make note of the exact bearing index location before removal so that it can be installed in the same position as it was in the preceding build-up.*

- f. Remove the thrust plate from the turbine and exhaust collector support.
- g. Remove the mating ring rotating seal from the power turbine shaft.
- h. Remove the oil bellows seal from the turbine and exhaust collector support with 6799973 puller and 6798928 protector. (See figure 3-41.)

----- **NOTE** -----

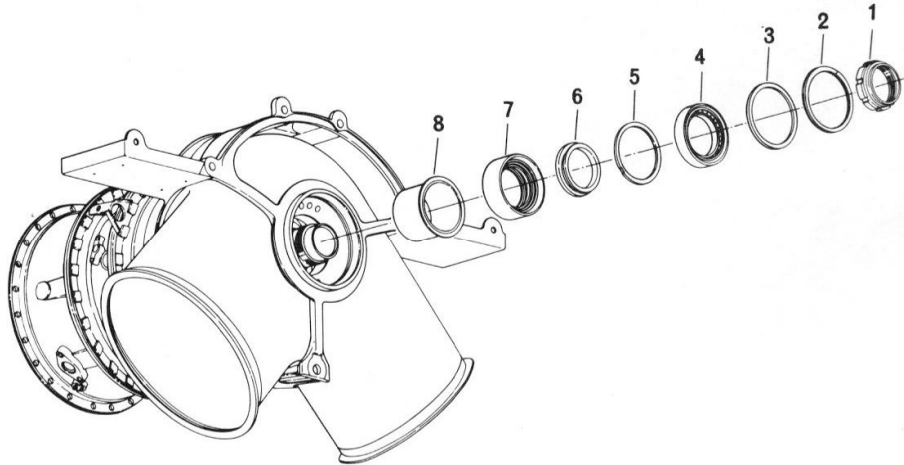
*To maintain the rotor total travel as in the preceding engine buildup, measure and record the new and old oil bellows seal thickness. Change the spacer (washer) thickness to account for any difference in seal thickness. The new seal plus the new spacers must be the same thickness as the old seal plus the old spacers. (See figure 3-42.)*

**3-157. Installation of the Oil Bellows Seal.** Install the oil bellows seal as follows:

- a. Thoroughly clean the bellows seal bore in the exhaust collector. Remove oil traces with methylethylketone. Apply a light coating of sealant (Permatex 1372, or equivalent) to the seal bore below the oil drain slots in the exhaust collector.
- b. Install the replacement oil bellows seal using 6796918 drift (E, figure 3-1). Chill the seal with dry ice to aid in assembly.
- c. Install the thrust plate and the mating ring rotating seal.
- d. Install the ball bearing on the power turbine shaft using 6796972 pusher (G, figure 3-1) and guide (-2) of 6796918 drift assembly. The pusher locks on the splines inside the power turbine shaft.

----- **NOTE** -----

*Install the bearing in the position noted at disassembly.*



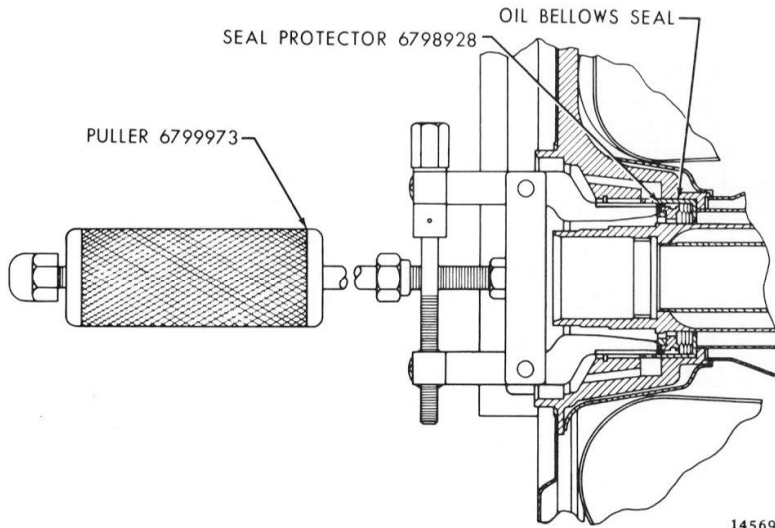
- 1. Spanner Nut
- 2. Internal Retaining Ring
- 3. Spacer (Washer)

- 4. Ball Bearing
- 5. Thrust Plate
- 6. Mating Ring Seal

- 7. Oil Bellows Seal
- 8. Power Turbine Shaft Shield

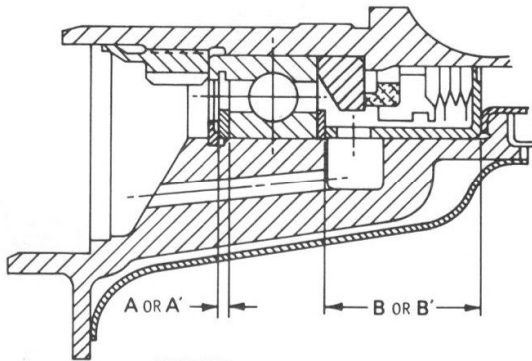
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Figure 3-40. Oil Bellows Seal Removal



14569

Figure 3-41. Pulling the Oil Bellows Seal from the Turbine and Exhaust Collector Support



DIMENSION

- A = OLD SPACER
- A' = NEW SPACER
- B = OLD SEAL
- B' = NEW SEAL
- A' = (A+B) - B'

8853A

Figure 3-42. Determining Spacer Thickness

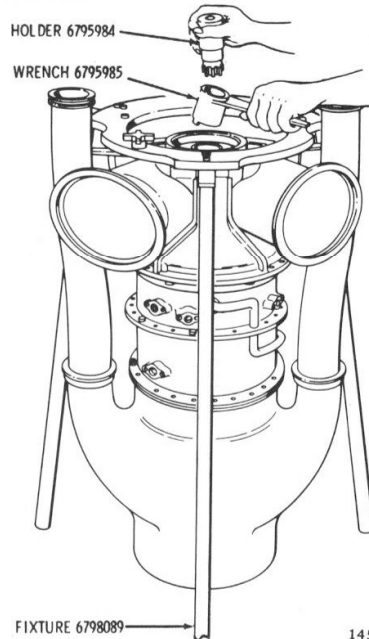


Figure 3-43. Installing Power Turbine Shaft Spanner Nut

e. Insert spacers (washers) and internal retaining ring. Retain bearing stack with spanner nut lightly lubricated with engine oil. Tighten the nut to 250-300 lb in. (28.25-33.90 N·m) using 6795985 wrench and 6795984 holder. (See figure 3-43.) Stake nut edge into lock detent using 6798927 crimper; do not use a previous locking position.

f. Remove the turbine and combustion section assembly from 6798089 supporting adapter (M, figure 3-1).

g. Install the firewall on the front of the turbine. Retain with two each nuts, bolts, and washers. Coat threads of bolts lightly with antiseize compound before installation. Tighten nuts to 35-40 lb in. (3.95-4.52 N·m).

h. Apply engine oil lightly to the splines, then install the turbine-to-compressor coupling on the spur adapter gearshaft and the turbine shaft-to-pinion gear coupling with two new O-rings on the turbine rotor.

i. Install the turbine and combustion section assembly on the power and accessories gearbox. (Refer to the applicable portions of Replacing the Turbine Assembly, para 3-158.)

j. Make an engine check run. (Refer to Check Run, para 3-174.)

**3-158. Replacing the Turbine Assembly.** Replace the turbine assembly as follows:

----- CAUTION -----

Check the 250-B17 Illustrated Parts Catalog Pub. No. 11W4 for compatibility of the turbine with the gearbox before ordering a replacement for either part.

- a. Remove the coordinator. (Refer to Coordinator Assembly, para 3-98.)
- b. Remove the bolt and washer securing the power turbine cable aft support bracket to the fire shield. (See figure 3-15.)
- c. Remove the gas producer fuel control. (Refer to Gas Producer Fuel Control Replacement, para 3-84.)
- d. Remove the power and accessories gearbox-to-check valve and the check valve-to-fire shield pressure oil tubes.
- e. Remove the power and accessories gearbox-to-fire shield scavenge oil tubes.
- f. Remove the spark igniter lead.
- g. Disconnect the thermocouple lead from the aircraft terminal block.
- h. Remove the drain hoses from the exhaust collector support, fire shield, and burner drain valve.
- i. Disconnect the fire shield-to-fuel nozzle hose. Cap the fuel nozzle.



j. Remove the gas producer support-to-fire shield and the external sump-to-fire shield scavenge oil tubes.

k. Remove the bolt and washer securing the fire shield to the support bracket at the combustion case splitline. Remove the fire shield.

l. Remove the internal retaining rings attaching the compressor discharge air tubes to the combustion outer case. Remove the 24 screws and nuts at the splitline and separate the combustion section from the turbine and from the discharge air tubes.

m. Remove the two compressor discharge air tubes and make the following inspection of the seal groove lands and of the split seal rings at the compressor (small) end.

(1) Remove the split seal rings from the small end of the air tubes.

(2) Replace the split seal rings if the edges show wear which could be detrimental to the sealing effect or if the expander ring is broken.

(3) Inspect the discharge air tube lands in accordance with figure 3-46C.

(4) Apply antiseize compound to the components of the split seal rings. Install the rings on the discharge air tubes. Split seal ring gaps should be 180° apart.

n. Remove the burner drain valve from the outer combustion case. Wash the valve in hot detergent, rinse in water and blow dry. Install the cleaned valve in the outer combustion case. Tighten valve to 120-140 lb in. (13.56-15.82 N-m).

o. Remove the five nuts at the splitline and separate the turbine from the power and accessories gearbox. (See figure 3-44.)

p. Remove the turbine shaft-to-pinion gear and the turbine-to-compressor couplings. Discard O-rings.

q. Make the following inspection of the turbine to compressor coupling splines.

(1) Run (or scribe) a suitable pointed object across the spline surfaces at both coupling ends to check for a wear step.

(2) Reject the coupling if the pointed object catches on the wear step. Polished spline surfaces are acceptable. If there is any doubt on the depth of the wear step, reject the coupling.

3-159. Install the replacement turbine as follows:

a. Apply engine oil lightly to the splines of the two turbine couplings. Install the compressor-to-turbine coupling on the turbine second-stage splined adapter. Lubricate two new O-rings and install them on the turbine shaft-to-pinion gear coupling. Install the coupling on the rotor of the replacement turbine with the end having the four equally spaced grooves out (toward the gearbox).

b. Lubricate O-ring and place it on the back of the power and accessories gearbox. Install the replacement turbine on the gearbox. Turn the gear trains with 6799790 engine turning adapter (Q, figure 3-1) as necessary to allow the coupling splines to mate. Retain the turbine with five nuts. Coat stud threads lightly with antiseize compound before installation. Tighten the bottom nut ( $5/16$ -24) to 110-120 lb in. (12.43-13.56 N-m) and the four top nuts ( $1/4$ -28) to 55-65 lb in. (6.21-7.34 N-m).

c. Place the packing, seal ring, and wave washers over the small end of one compressor discharge air tube, then insert the tube through the firewall into the diffuser scroll. Use 6799953 installation clamp (S, figure 3-1) to compress the split seal ring for the installation. Install the second air tube in the same manner.

d. Slip the retaining rings over the large ends of the compressor discharge air tubes.

e. Place the combustion liner over the first-stage turbine nozzle shield with the igniter plug opening at the nine o'clock position (looking forward).

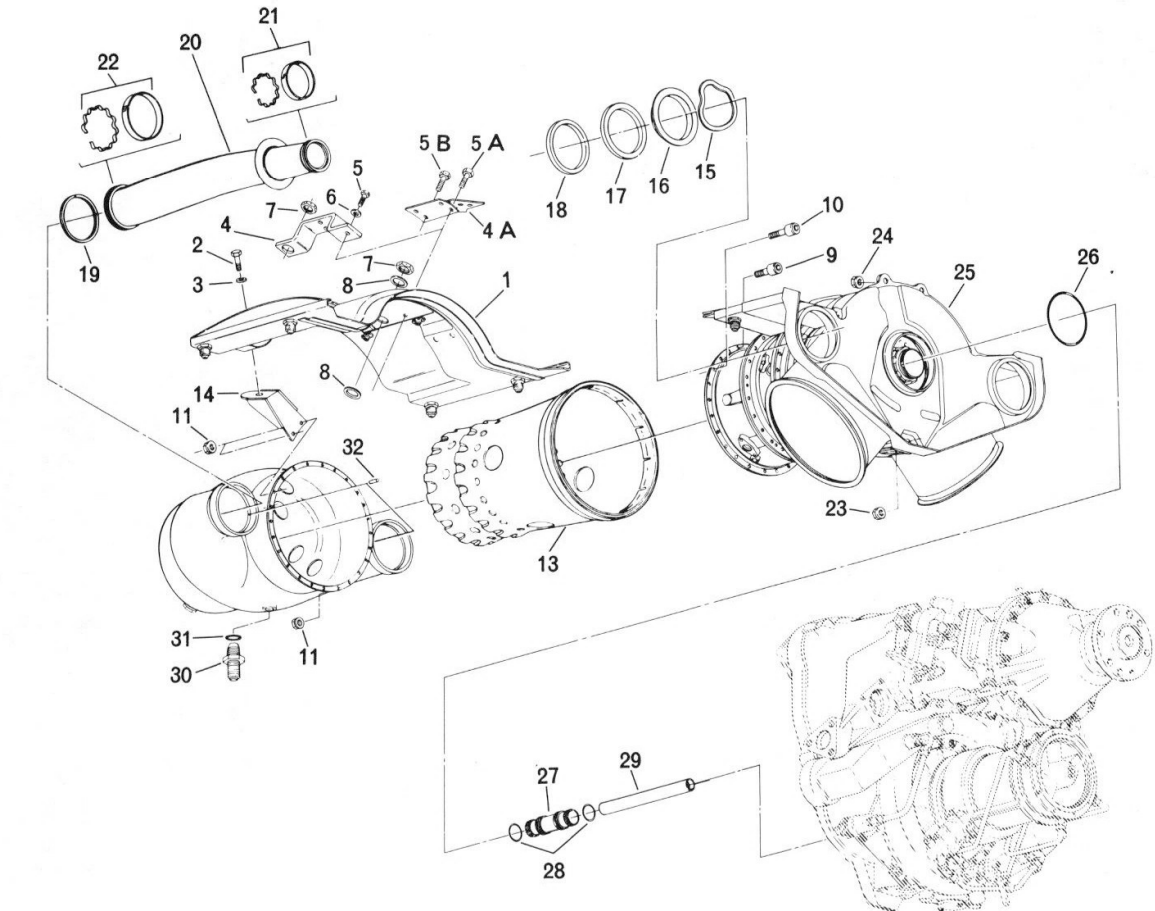
f. Compress the seal rings with 6799952 installation clamps (R, figure 3-1). Place the outer combustion case over the liner while mating it to the compressor discharge air tubes. The fire shield aft support bracket and two half-inch bolts go at bolt positions 4 and 5. Locate the bracket on the aft side of the splitline. Secure the outer case to the turbine with 24 bolts and nuts. Coat bolt threads lightly with antiseize compound before installation. Tighten nuts of socket head cap screws to 20-30 lb in. (2.26-3.39 N-m). Tighten nuts of Tee-head bolts to 35-40 lb in. (3.95-4.52 N-m). Remove installation clamps and secure the air tubes with retaining rings.

g. Place a washer on the pressure oil manifold and install the fire shield. Secure fire shield at the aft support bracket with a bolt and washer.

h. Install the power and accessories gearbox-to-fire shield scavenge oil tubes. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N-m).

i. Install the coordinator aft bracket. Secure to the manifold with a nut; secure to the fire shield with a bolt and washer. Tighten nut to 100-150 lb in. (11-17 N-m). Tighten bolt to 70-85 lb in. (7.9-9.6 N-m). On more recent configurations, secure the manifold to the fire shield with a nut and washer. Tighten to 15-20 lb in. (1.7-2.3 N-m) then install the coordinator bracket. Secure with four bolts. The drilled head bolt goes at the position nearest to the gas produce support pressure oil fitting. Tighten bolts to 35-40 lb in. (3.9-4.5 N-m) and lockwire drilled bolt to oil fitting.

j. Install the power and accessories gearbox-to-check valve pressure oil tube. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N-m).



9193B

- |                |                             |  |
|----------------|-----------------------------|--|
| 1. Fire Shield | 10. Screw (2)               | 22. Split Ring (2)                           |
| 2. Bolt        | 11. Nut (24)                | 23. Nut                                      |
| 3. Washer      | 12. Outer Combustion Case   | 24. Nut (4)                                  |
| 4. Bracket     | 13. Liner                   | 25. Turbine                                  |
| 4A. Bracket    | 14. Bracket                 | 26. O-ring                                   |
| 5. Bolt        | 15. Wave Washer (2)         | 27. Turbine Shaft-to-Pinion<br>Gear Coupling |
| 5A. Bolt (3)   | 16. Ring (2)                | 28. O-ring (2)                               |
| 5B. Bolt       | 17. Packing (2)             | 29. Turbine-to-Compressor Coupling           |
| 6. Washer      | 18. Spacer (2)              | 30. Burner Drain Valve                       |
| 7. Nut         | 19. Internal Retaining Ring | 31. O-ring                                   |
| 8. Washer (2)  | 20. Discharge Air Tube      | 32. Pin                                      |
| 9. Screw (22)  | 21. Split Ring (2)          |  |

Figure 3-44. Turbine Removal



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k. Install the gas producer support-to-fireshield and the external sump-to-fire shield scavenge oil tubes. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N·m).

l. Remove the cap from the fuel nozzle and install the fire shield-to-fuel nozzle hose. Tighten coupling nut to 80-120 lb in. (9.04-13.56 N·m).

m. Install the gas producer fuel control. (Refer to Gas Producer Fuel Control Replacement, para 3-84.)

n. Install the coordinator. (Refer to Coordinator Assembly, para 3-98.)

o. Install the check valve-to-fire shield pressure oil tube. Tighten coupling nuts to 150-200 lb in. (16.95-22.60 N·m).

p. Install the spark igniter lead. Tighten coupling nut to 70-90 lb in. (7.91-10.17 N·m).

q. Install all drain hoses at the exhaust collector support, fire shield and burner drain valve.

r. Connect the thermocouple lead to the aircraft terminal block.

s. Make a check run of the engine. (Refer to Check Run, para 3-174.)

### 3-160. COMBUSTION SECTION.

**3-161. Combustion Liner Inspection.** Replace the combustion liner if any of the following limits are exceeded. (See table III-9). Remove the combustion section for the inspection in accordance with Replacing the Combustion Liner, para 3-162.

3-162. Replacing the Combustion Liner. Replace the combustion liner as follows: (See figure 3-44.)

a. Remove the coordinator assembly. (Refer to Coordinator Assembly, para 3-98.)

b. Remove the eight bolts and washers and remove the fire shield access panel.

c. Disconnect the fuel hose at the fuel nozzle. Cap the fuel nozzle and plug the hose.

d. Disconnect the spark igniter lead at the spark igniter. Ground the lead to the engine to dissipate any stored energy.

e. Remove the drain hose from the burner drain valve.

----- **NOTE** -----

*If the outer combustion case is also being replaced, remove the spark igniter, fuel nozzle and burner drain valve.*

f. Remove the internal retaining rings attaching the compressor discharge air tubes to the outer combustion case.

g. Remove the 24 screws and nuts at the splitline and separate the outer combustion case from the turbine.

Leave the compressor discharge air tubes installed in the diffuser scroll.

h. Remove the combustion liner.

3-163. Install the replacement combustion liner as follows:

a. Place the combustion liner over the first-stage turbine nozzle shield with the igniter plug opening at the nine o'clock position (looking forward).

b. Slip the retaining rings over the large ends of the compressor discharge air tubes.

c. Install the spark igniter, fuel nozzle and burner drain valve if they were removed. Required torques are: spark igniter 150-200 lb in. (16.95-22.60 N·m), fuel nozzle 200-300 lb in. (22.60-33.90 N·m) and burner drain valve 120-140 lb in. (13.56-15.82 N·m).

d. Compress the seal rings with 6799952 installation clamps, (R, figure 3-1). Place the outer combustion case over the liner while mating it to the compressor discharge air tubes. Secure the outer case to the turbine with 24 bolts and nuts. Coat bolt threads lightly with antiseize compound before installation. Retained on this splitline is the fire shield supporting bracket (positions 4-5). Positions are determined with 1 at top center when looking forward. These two positions take the half-inch bolts. Tighten bolts of socket headcap screws to 20-30 lb in. (2.26-3.39 N·m). Tighten nuts of Tee-head bolts to 35-40 lb in. (3.95-4.52 N·m). Seat the air tube retaining rings in the retaining ring grooves.

e. Install the following on the outer combustion case.

(1) Ignition lead to spark igniter. Tighten coupling nut to 70-90 lb in. (7.91-10.17 N·m).

(2) Fuel hose to the fuel nozzle. Tighten coupling nut to 80-120 lb in. (9.04-13.56 N·m).

(3) Drain hose to the burner drain valve.

f. Reinstall the fire shield access panel and secure with eight washers and bolts.

g. Reinstall the coordinator. (Refer to Coordinator Assembly, para 3-98.)

h. Check run the engine after combustion section replacement. (Refer to Check Run, para 3-174.)

**3-164. Outer Combustion Case.** Inspect, repair or replace the outer combustion case in accordance with table III-9A. After any repair, make a careful, visual, leakage inspection of the outer case during the check run. No leakage is acceptable.

**3-165. Compressor Discharge Air Tubes.** Inspect the compressor discharge air tubes in accordance with table III-9B. After any repair, make a careful, visual, leakage inspection of the tube during the first engine operation following installation of the repaired part. No leakage is acceptable.





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TABLE III-9

<b>Combustion Liner Inspection and Repair</b>				
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
1	Louvers bent closed or restricted by carbon particles.	Maintain 0.060-0.065 in. (1.52-1.65 mm) uniform opening.		Lightly wire brush as required. Vapor degrease or clean in perchlorethylene; then reposition by bending to proper opening.
2	Burnt louvers.	Refer to figure 3-44A for maximum material which can be burned away from individual louvers.		Replace liner or send to an overhaul facility for repair.
3	Pulled or broken spotwelds at liner step.	Max of six with no more than three adjacent welds.	Four adjacent spotwelds or up to 40% of total per step.	Plugweld repair. Drill 3/16-in. (4.8 mm) dia hole through outer section then press sections together and plugweld using 29-9 W Mo weld rod (AMS 5784). Grind weld material only if it blocks or restricts airflow.
4	Handling damage — mashed out of round.	None.	Unable to straighten to concentricity limits.	Straighten and reform.
5	Handling damage — dented.	None.	Unable to straighten to concentricity limits or dent causes thin-out metal.	Straighten and reform dents in allowable areas indicated on fig. 3-45.
6	Localized high temperature distortion indicated by warping of liner surface (normally accompanied by discoloration).	Max of 3/16-in. (4.8 mm) depth over 1 in. (25 mm) dia and within allowable areas given on fig. 3-45.		Replace liner or send to an overhaul facility for repair.
7	Burning in area of relief slots.	Max of 1/16-in. (1.6 mm) on rear edge or both corners burned max of 1/4-in. (6.4 mm) along relief slot.		Replace liner or send to an overhaul facility for repair.
8	Distortion in dome or exit end of liner.	None.		Replace liner or send to an overhaul facility for repair.

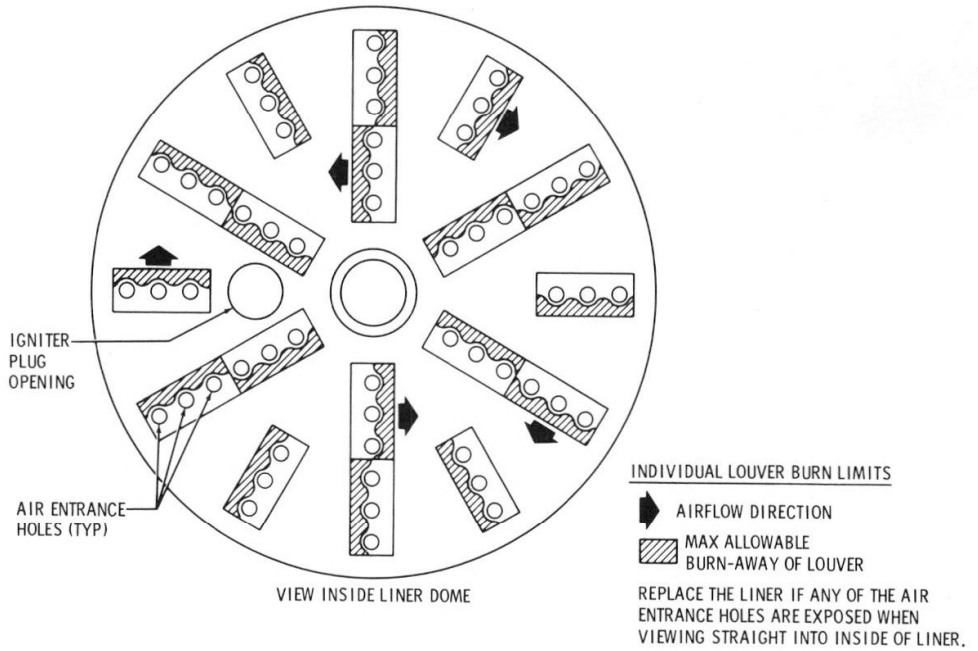


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TABLE III-9 (cont)

<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
9	Cracks on outside of liner(dye check).	None.		Gas tungsten - arc weld using 29-9 W Mo weld rod (AMS 5784).Crack must be completely welded. Weld material must not obstruct cooling air passage.
10	Crack in tab end inside liner (dye check).	Max of 1/4-in. length and limited to 2 cracks per tab.	Three or more cracks, or one or more cracks in excess of 1/4 in. in length.	Replace liner or send to an overhaul facility for repair.
11	Cracks at two adjacent relief slots progressing toward same hole (dye check).	None.		Replace liner or send to an overhaul facility for repair.
12	Crack in relief slot at combustion liner steps (dye check).	Max of 3/16-in. in length (any number).	Cracks over 3/16-in. with other cracks extending more than 3/8-in. toward air holes.	Gas tungsten - arc weld using 29-9 W Mo weld rod (AMS 5784.)Grind weld material only if it blocks or restricts airflow.
13	Crack in double lip area (dye check).	None.		Gas tungsten - arc weld using 29-9 W Mo weld rod (AMS 5784). Surfaces between lips must be free of weld material.
14	Cracks in expansion slots.	Max of 3/16-in. length.		Replace liner or send to an overhaul facility for repair.
15	Crack in igniter or fuel nozzle ferrule attaching weld (dye check).	None.		Gas tungsten - arc weld using Hastelloy X weld rod (AMS 5798). Max width of weld 0.080 in.
16	Roughened igniter ferrule ID.	Max of 0.560 in. ID after polishing		Send liner to an overhaul facility for repair if not within Serviceable Limit after polishing.
17	Worn or distorted (out-of-round) igniter ferrule.	Min of 0.020 in. wall thickness and max of 0.560 in. ID.		Replace liner or send to an overhaul facility for repair.
18	Worn or distorted (out-of-round) fuel nozzle ferrule.	Max of 0.670 in. ID.		Replace liner or send to an overhaul facility for repair.



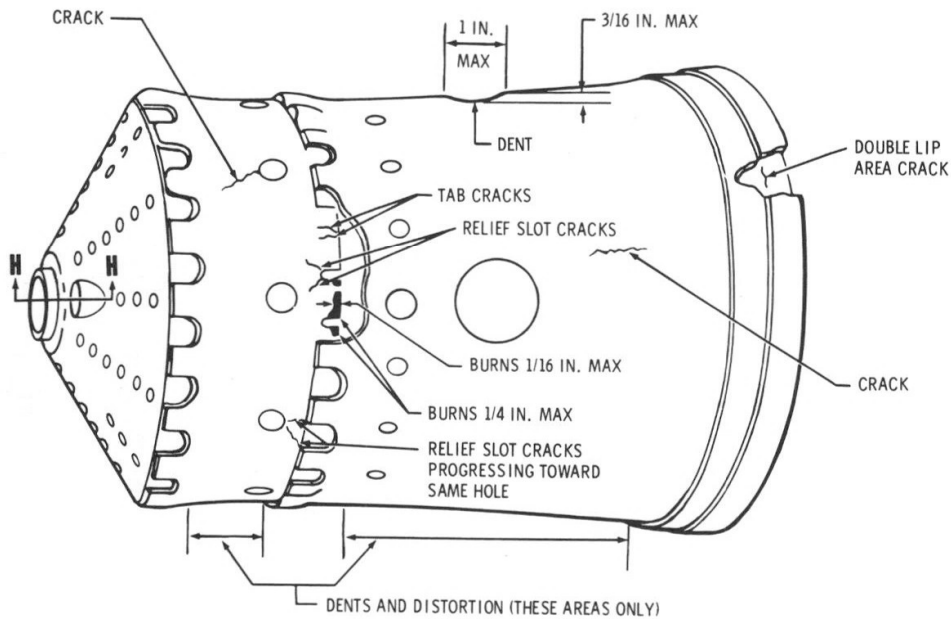
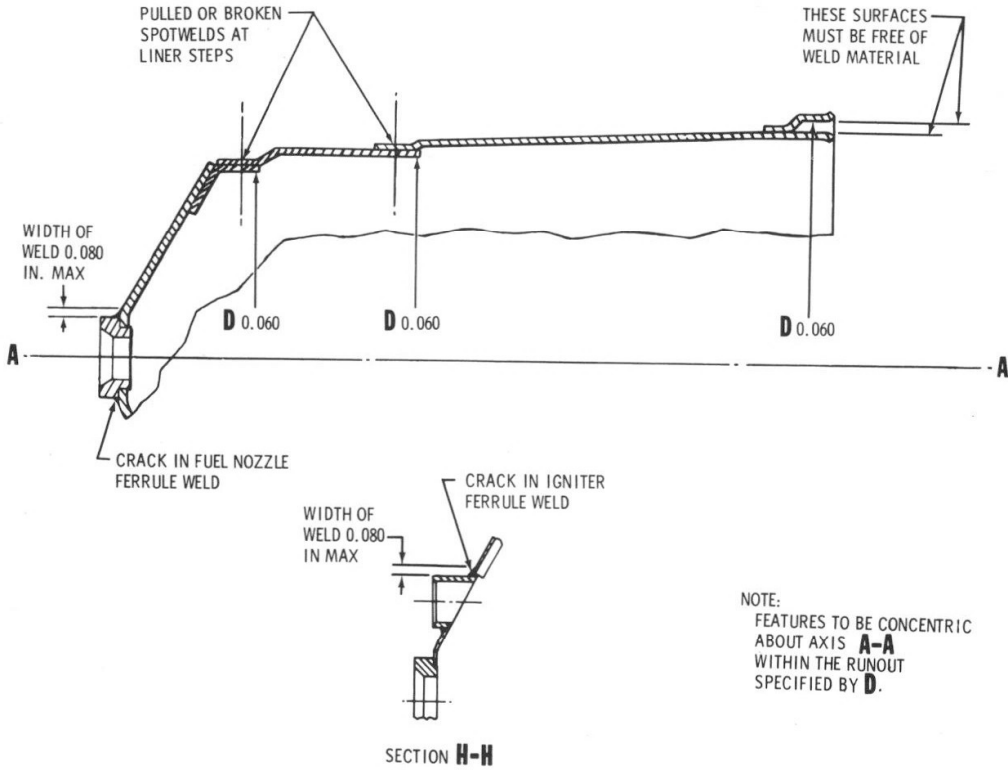
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Figure 3-44A. Inspection of Combustion Liner Dome Louvers



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9426

Figure 3-45. Combustion Liner Inspection and Repair



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TABLE III-9A

Outer Combustion Case Inspection				
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
1	Cracks in outer shell (dye check).	None.		Weld using 29-9 W Mo weld rod (AMS 5784) or send case to an over-haul facility for the repair. Wall thickness shall be 0.016 in. minimum in areas A and B of fig. 3-46 after weld repair.
2	Cracks in liner inner basket (dye check).	None.		Weld using 29-9 W Mo weld rod (AMS 5784) or send case to an over-haul facility for the repair.
3	Entrapped material under liner gasket (visual - dental mirror and/or borescope).	None.		Dislodge entrapped material using locally fabricated wire hooks. Remove all foreign material.
4	Stripped or crossed threads in fuel nozzle or drain valve bosses.	None.	Max of one damaged thread per boss.	Chase threads.
5	Dents.	Area A, figure 3-46A: Max of one dent up to 1/8-in. depth x 3 in. length x 1 in. width. Any other area: Max of 3 dents up to 1/4-in. depth and 1 in. dia.		Straighten and reform.
6	Crack in drain plug boss (dye check).	None.		Weld using 29-9 W Mo weld rod (AMS 5784) or send case to an over-haul facility for the repair.



TABLE III-9A (cont)

Item	Condition	Serviceable Limit	Repairable Limit	Disposition
7	Crack in fuel nozzle or igniter plug boss (dye check).	None.		Weld using 29-9 W Mo weld rod (AMS 5784) or send case to an overhaul facility for the repair.
8	Wear in air tube boss (See fig. 3-46B.)	Max of 0.004 in. wear (measured from adjacent unworn area).		Send case to an overhaul facility for repair.
9	Out of round at air tube boss. (See fig. 3-46B.)	Max of 0.004 in. out of round.		Send case to an overhaul facility for repair.

**3-166. Burner Drain Valve.** Remove, clean, install, and check the burner drain valve as follows:

- a. Remove the burner drain valve. Use a wrench on the drain valve boss to offset torque when removing the valve.
- b. Clean the valve in carbon solvent (Cities Service No. 26 or equivalent). Flush the valve with Stoddard solvent or kerosene. Pass fluid through the valve to verify that it is open. Blow dry with clean shop air.
- c. Lubricate O-ring and place it on the burner drain valve. Install the valve in the outer combustion case. Tighten to 120-140 lb in. Use a wrench on the boss to offset torque.
- d. Start the engine and check that the valve is closed to the passage of air. Replace valve if it does not close when the engine is operating. Attach drain hose to valve.

**3-167. POWER AND ACCESSORIES GEARBOX.**

**3-167A. Power and accessories gearbox** (hereafter referred to as the gearbox) maintenance includes: inspection and repair of compressor mounting inserts; inspection for oil leaks; replacement of oil seals; replacement of the gearbox; disassembly and assembly of the gearbox for part replacement and disassembly, inspection and assembly of the oil pump.

**3-167B. Opened Gearbox Inspection.** Whenever the gearbox is opened for any reason, make a general visual inspection of the assembly, paying particular attention to the following:

- a. Check condition of accessory gearshaft drive splines. If excessive wear is believed present, replace the gearshaft.
- b. Check condition of gears. Replace gears having spalled or chipped teeth.
- c. Check mounting and attachment security of all internal parts including tab lock washers and safety wire. Secure as required.

d. Check integrity of oil pump attaching screws and oil tube O-rings.

----- **NOTE** -----  
*If any doubt exists concerning the serviceability of any part, repair or replace the part before closing the gearbox.*

- e. Check the condition of the accessory pad seal for the gas producer gear train idler spur gearshaft (inside the gearbox cover). Replace seal if it shows apparent damage or if the engine is prone to blow oil out the gearbox vent.
- f. Check the filter housing for excessive wear at the openings for the filter inlet and filter bypass tubes. Replace O-rings on the filter inlet and bypass tubes at each disassembly. Replace the filter housing if necessary to prevent internal air/oil leakage.

**3-167C. Insert Inspection.** Any time the compressor is removed or when insert looseness is known or suspected, check for space between each of the five inserts and the gearbox housing. If a piece of 0.0015 in. shim stock can be inserted anywhere under the insert, the insert is loose and must be reworked.

**3-167D. Repair of Compressor Mounting Inserts.** Repair loose compressor mounting inserts in the gearbox housing as follows:

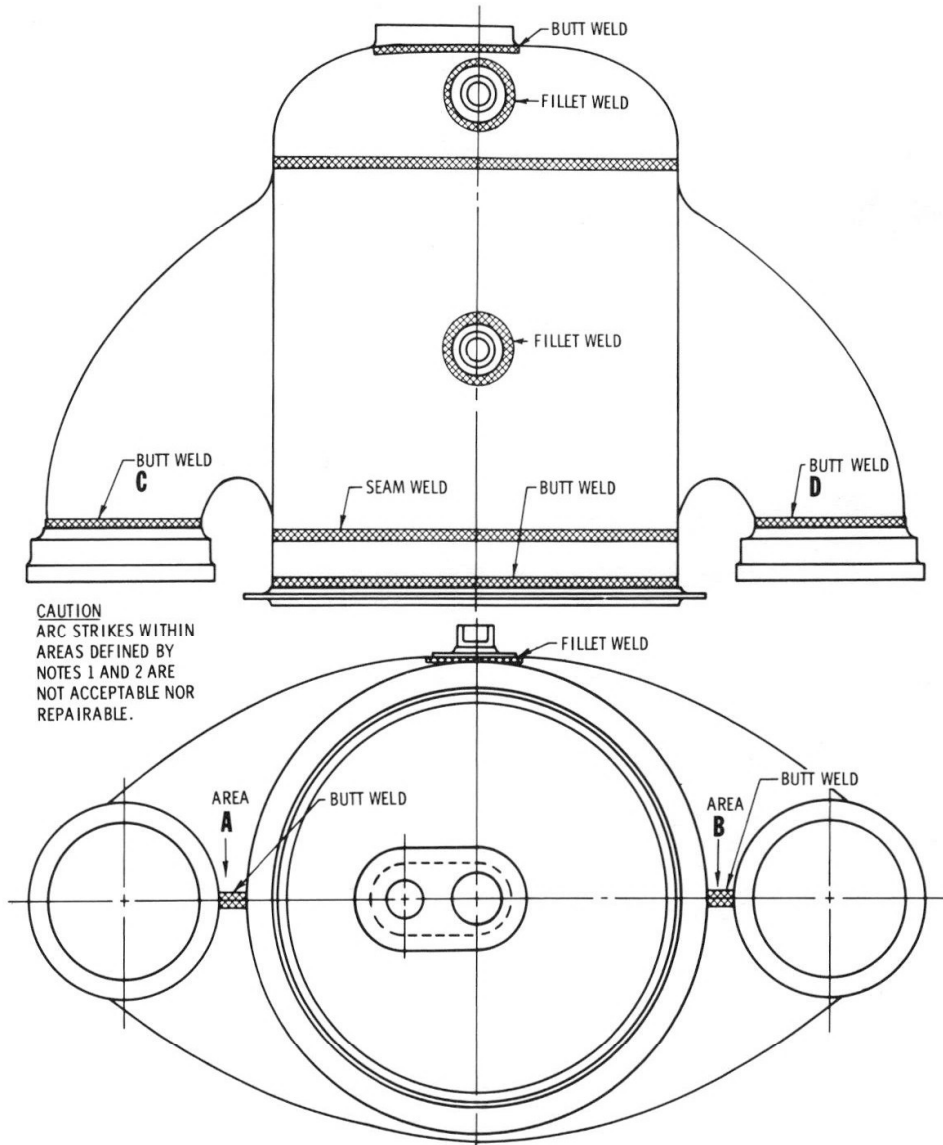
----- **CAUTION** -----  
*The gearbox housing must have at least three good compressor mounting inserts before rework can be accomplished on a loose insert.*

----- **NOTE** -----  
*The rework shall be made with the engine removed from the airframe and with the turbine and compressor assemblies removed from the gearbox. (Refer to Replacing the Compressor Assembly, para 3-147.)*



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**CAUTION**  
ARC STRIKES WITHIN  
AREAS DEFINED BY  
NOTES 1 AND 2 ARE  
NOT ACCEPTABLE NOR  
REPAIRABLE.

**NOTES**

WELD REPAIR ON PART NOT PERMITTED:

1. IF WITHIN 1/4 IN. OF BUTT WELD IN AREAS **A** AND **B**.
2. IF WITHIN 1/4 IN. OF BUTT WELD **C** AND **D**.
3. IF WITHIN ORIGINAL FLANGE BUTT WELDS AND LARGER THAN REQUIRED TO REPAIR A PIN HOLE LEAK.
4. IF IN FLANGE MATERIAL. (SEE NOTE 3.)

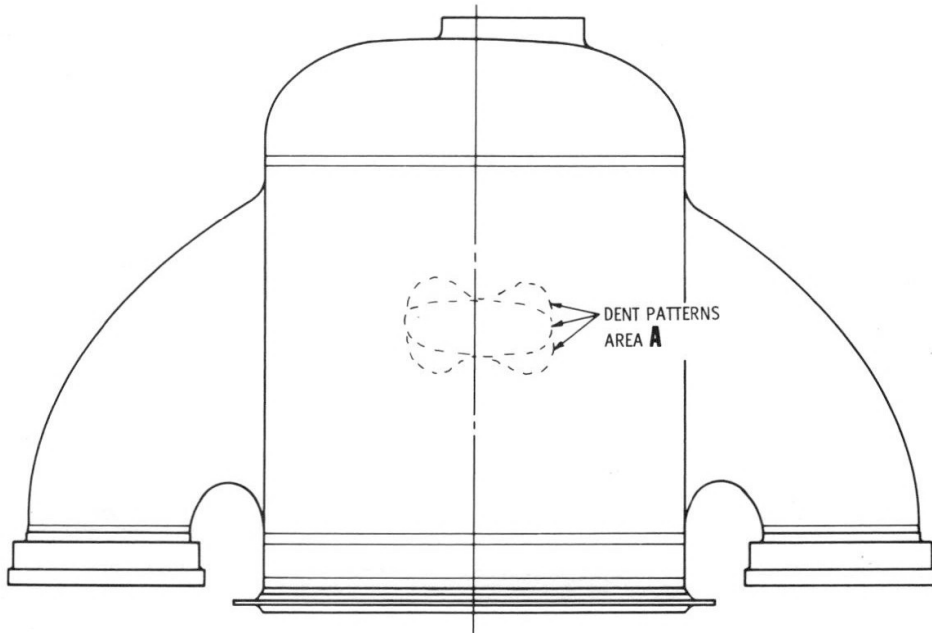
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Figure 3-46. Weld Repairable Areas of Outer Combustion Case



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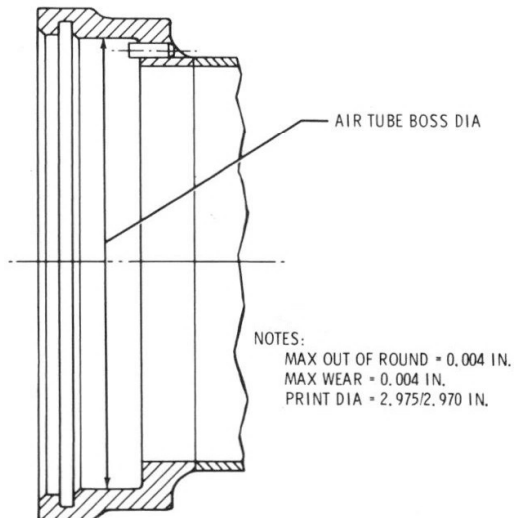


MAX DENT LIMIT

AREA A ONE DENT, 1 IN. x 3 IN. x 1/8 IN. DEPTH

6876A

Figure 3-46A. Dent Limits—Top of Outer Combustion Case



11156

Figure 3-46B. Outer Combustion Case Air Tube Boss



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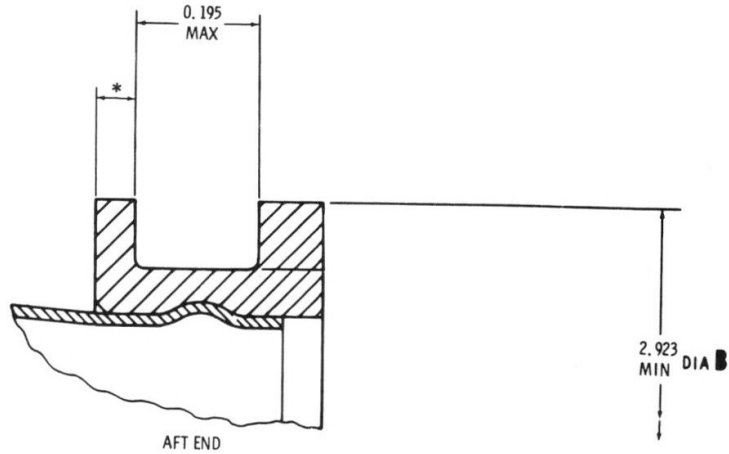
TABLE III-9B

<b>Compressor Discharge Air Tube Inspection</b>				
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
1	Cracks (dye check).	None.	Max of 3 in. (any number).	Weld using 29-9 W Mo weld rod (AMS 5784). Pressure test in 6798787 fixture at 150-160 psig (1034-1103 kPa) for three minutes. No leakage is acceptable. Send tube to an overhaul facility for repair.
2	Dents.	Max of 3 dents per tube up to 1/8-in. depth by 1/2-in. dia.		Straighten and reform. Dye check after repair.
3	Wear in seal ring groove.	See figure 3-46C.		See figure 3-46C.
4	Wear on land surface.	See figure 3-46C.		See figure 3-46C.
5	Wear of sheet metal surface.	No appreciable loss of metal thickness.	½ sheet metal thickness.	Repair using brazed screen patch or replace. Pressure test in 6798787 fixture at 100 psig for 3 minutes. No leakage acceptable.



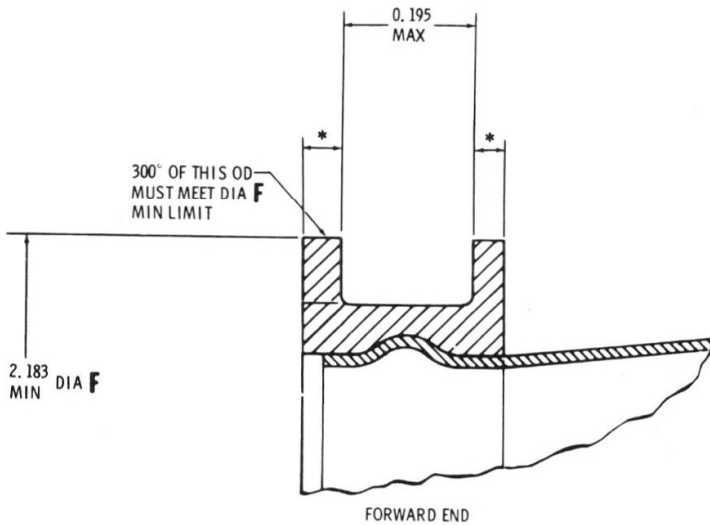
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REPAIR:  
WHEN SPECIFIED SERVICEABLE LIMITS  
ARE EXCEEDED. RESTORE DETAILS TO  
LATEST DRAWING DIMENSIONS BY  
WELD BUILD-UP OR METAL SPRAY  
USING METCO 450 THERMO OR  
PLASMA APPLICATION.

\* 0.040 IN. MINIMUM PARENT  
STOCK REMAINING WHEN  
PREPARING FOR REPAIR.



INCH	MILLIMETRE
0.040	1.02
0.195	4.95
2.183	55.45
2.923	74.24

8733E

Figure 3-46C. Compressor Discharge Tube Inspection and Repair



- a. Clean the area of the loose insert on the gearbox housing with methylethylketone.
- b. If the insert is pinned, use a No. 53 drill to drill out the insert locking pin. Remove the insert using wrench 6872881 (EX97154) or 6872927 as applicable.
- c. File off the burrs and clean the threads and surrounding area of the housing using a brush and methylethylketone.
- d. Check the threads of the gearbox housing for wear. Check by reinstalling the removed insert in the threaded opening of the housing. The threads should be snug when the bottom side of the insert flange is 1/8-in. above the surface of the gearbox. If any side movement or wobble is present, use an oversized insert for the replacement. Select the oversized insert to obtain the best fit.

e. Install the selected insert. Tighten to 125-150 lb in. (14.12-16.95 N-m), above runing torque. Do not exceed 180 lb in. (20.34 N-m).

f. Install 6872880 (EX92634) checking fixture over the five compressor mounting inserts. (See figure 3-46D.) Be sure the fixture does not touch any of the four bosses around the insert at the seven o'clock position. Determine the seven o'clock position by viewing the gearbox from the front (compressor) side.

g. Use shim stock to feel for clearance between each insert flange and the bottom of the fixture. Rework insert flange using 6872879 (EX97156) spotfacing kit until there is no clearance at any of the five locations. (See figure 3-46E.)

----- **NOTE** -----  
*When properly installed and reworked the five compressor mounting inserts are the same height. In this condition the checking fixture rests on all five points and each insert-to-fixture fit will be closed to the passage of the shim stock feeler gage.*  
-----

h. Mark the gearbox boss at the location of the insert pin slot. Remove the insert using wrench 6872881 (EX97154) or 6872927 as applicable. Clean the threads of the insert and the gearbox using methylethylketone.

i. Deleted.

j. Apply the Resiweld 7111, or equivalent, sealer to the threads of the replacement insert. Thread the insert into the gearbox. The insert will apply sealer to the threads in

the gearbox. Repeat the application of sealer to the insert as necessary to cover all threads of both parts. Also, at the seven o'clock insert position, **do not** install the O-ring; however, be sure the O-ring groove is filled with sealer.

----- **CAUTION** -----  
*Wipe excess sealer from the end of the insert to make sure that none of the sealer enters the gearbox at the seven o'clock insert position through-hole. On bottom-holed insert locations, make sure the hole does not accumulate excess sealer which can push up through the inside thread of the insert. Clean sealer from insert inside threads before it hardens using methylethylketone and a 1/4-28 bolt. Retap (1/4-28) the inside thread if hardened sealer is encountered.*  
-----

k. Install the new insert. Tighten to 125-150 lb in. (14.12-16.95 N-m) plus running torque to a position where the pin slot aligns with the mark on the gearbox boss. (See step h.) **Do not** exceed 180 lb in. (20.34 N-m).

l. Wipe any excess sealer from the insert or gearbox. Recheck insert height. (See steps f and g.) Cure sealer for 25-35 minutes at 350°F (177°C), or as an option, at 300°F (149°C) for two hours (to combine cure cycle with paint bake cycle).

m. Install compressor and turbine assemblies on the gearbox. (Refer to Replacing the Compressor Assembly, para 3-147.)

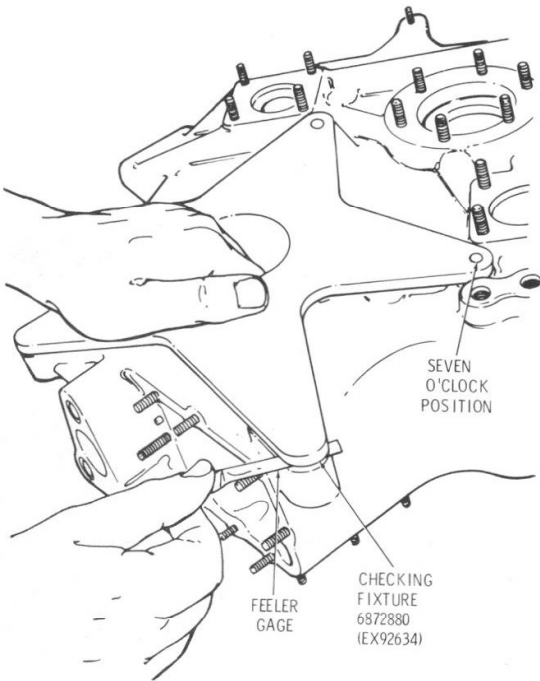
n. Return the engine to service. Inspect the insert at the five o'clock position for any sign of oil leakage after the check run. Repair the insert if any leakage is detected.

**3-168. Oil Leakage Inspection.** Inspect the power and accessories gearbox for oil leaks. Replace the seal assembly if excessive oil leakage is detected at the accessory pad locations. (See figure 3-47.)

3-169. Replacing Oil Seals. Replace leaking power and accessories gearbox seals as follows:

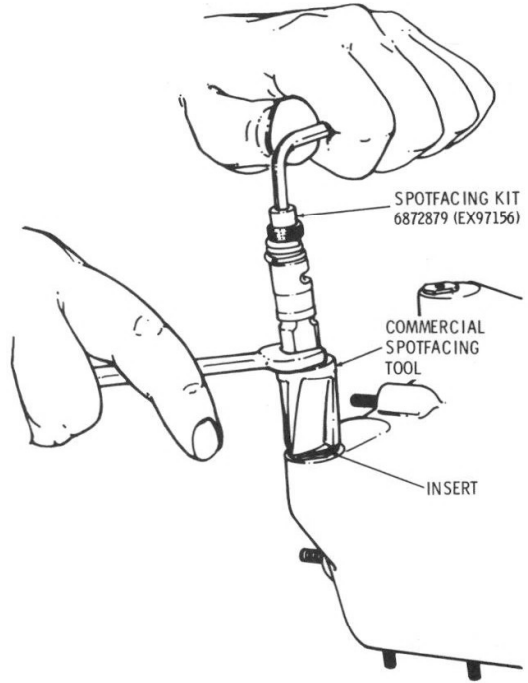
a. Remove the accessory or drive from the gearbox pad.

b. Use the seal replacement kit to remove the seal. (H, figure 3-1.) Be careful not to contaminate the shaft bearing or damage the gear shaft. The seal will be damaged during removal and consequently will not be salvageable.



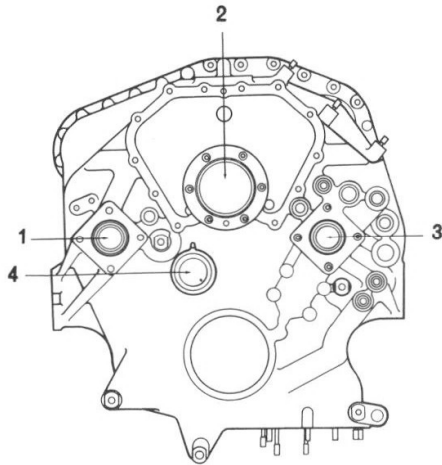
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Figure 3-46D. Checking Insert Setting Height



9891

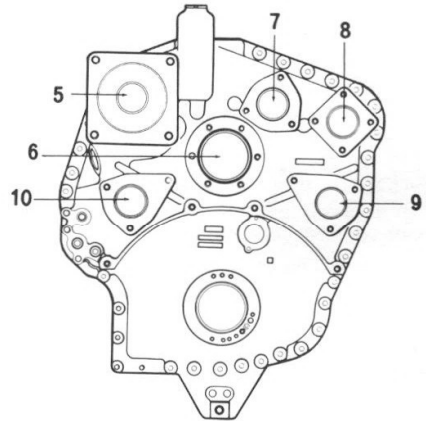
Figure 3-46E. Machining New Insert



**FRONT**

1. Power Turbine Tachometer-Generator Pad
2. Power Output Pad
3. Gas Producer Tachometer-Generator Pad
4. Torquemeter Spanner Nut

5819



**REAR**

5. Starter Generator Pad
6. Power Takeoff Pad
7. Fuel Pump Pad
8. Vacuum-Hydraulic Pad
9. Power Turbine Fuel Governor Pad
10. Gas Producer Fuel Control Pad

1214

**Figure 3-47. Power and Accessories Gearbox**

----- **CAUTION** -----  
*Do not pry between the seal cavity in the housing and the seal.*  
-----

c. Apply grease (Shell 6249, or equivalent) to the seal lip to aid the installation then carefully drive (or press) the replacement seal in place.

----- **CAUTION** -----  
*Do not use silicone lubricants except where specified. Use only the lubricants recommended in the engine publications.*  
-----

d. Reinstall the accessory or drive on the gearbox pad.

**3-170. Replacing the Power and Accessories Gearbox.**  
Replace the power and accessories gearbox as follows:

----- **CAUTION** -----  
*Check the 250-B17 Illustrated Parts Catalog Pub. No. 11W4 for compatibility of the turbine with the gearbox before ordering a replacement for either part.*  
-----

a. Remove the coordinator. (Refer to Coordinator Assembly, para 3-98.)

b. Remove the fuel control-to-governor  $P_Y$  air tube and propeller-power turbine governor-to-overspeed governor oil tube.

c. Remove the power turbine governor and propeller governor control cables and mounting brackets. (See figure 3-15.)

d. Remove the coordinator support forward bracket. (See figure 3-15.)

e. Remove the ignition exciter and start counter. (Refer to Ignition Exciter, para 3-124.)

f. Remove the fuel pump and filter assembly. (Refer to applicable portion of Fuel Pump and Filter, para 3-77.)

g. Remove the propeller overspeed governor. (Refer to Propeller Overspeed Governor, para 3-96.)

h. Remove the gas producer fuel control. (Refer to applicable portion of Gas Producer Fuel Control, para 3-84.)

i. Remove the turbine assembly. (Refer to Replacing the Turbine Assembly, para 3-158.)

j. Remove the propeller reduction gearbox. (Refer to the applicable portion of Propeller Reduction Gearbox Replacement, para 3-171.)

k. Remove the compressor (with  $P_c$  filter). (Refer to applicable portion of Replacing the Compressor Assembly, para 3-147.) Remove tubing only as necessary to separate the compressor from the gearbox.



----- **CAUTION** -----

*Do not use the igniter plug, fuel nozzle or any lines or tubing as handles for maneuvering the turbine and combustion section assembly during the installation.*

- l. Remove the beta valve cover. (Refer to applicable portion of Propeller and Beta Control Valve, para 3-107.)
- m. Remove the engine identification plate.
- n. Transfer fittings and accessory pad covers from the rejected to the replacement gearbox as required.
- o. Reassemble the engine using the replacement gearbox. Assemble in reverse of the order of removal using the assembly portion of the referenced removal paragraphs.
- p. Make appropriate entry relative to gearbox replacement in the Engine Log.
- q. Check run the engine after gearbox replacement. (See Check Run, para 3-174.)

----- **NOTE** -----

*When the power and accessories gearbox has been replaced, check the system oil level before and after the check run.*

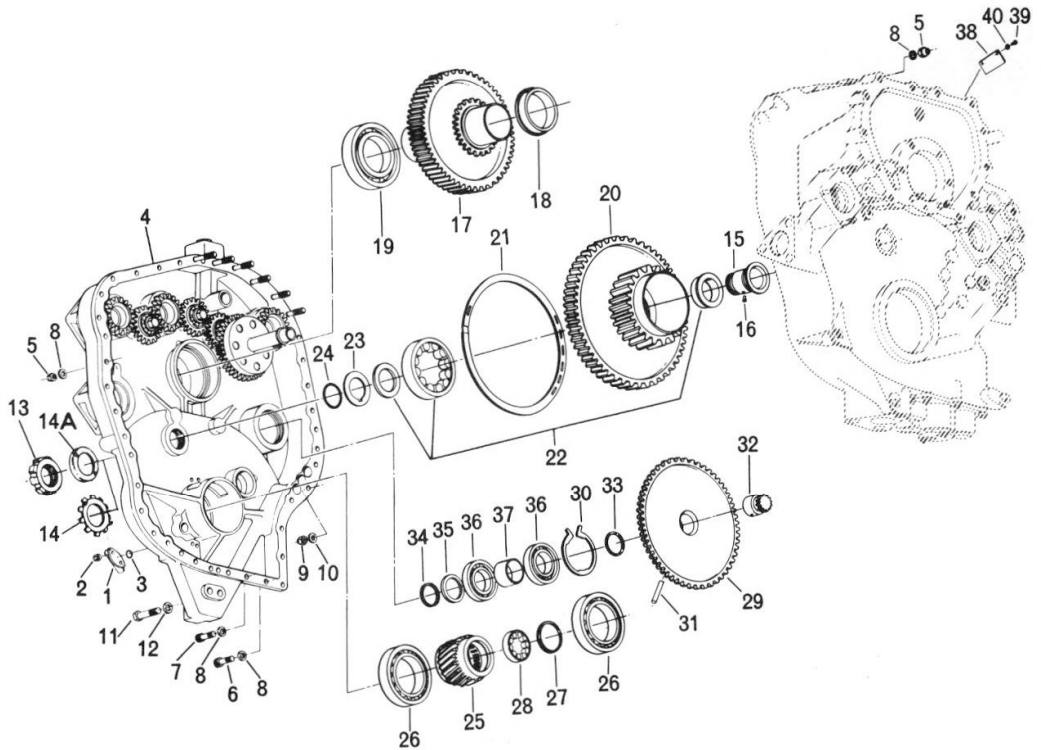
**3-170A. Gearbox Disassembly and Assembly.** Applicable parts of the following procedure may be used by any knowledgeable and qualified maintenance facility to perform part replacement in the gearbox. Return the gearbox to an Overhaul Facility if repair beyond part replacement is required or if metal particles are detected inside the gearbox.

**3-170B. Gearbox Disassembly.** To disassemble the gearbox, remove the engine from the aircraft and separate the gearbox from the engine. (Refer to Replacing the Power and Accessories Gearbox, para 3-170). Install the gearbox in 6795579 turnover stand (or equivalent). Remove the 39 nuts, 4 bolts, and 43 washers at the splitline and separate the cover from the housing. (See figure 3-47A.)

**3-170C. Gearbox Cover Disassembly.**

**3-170D. Disassemble the gearbox cover as follows:**

- a. Remove the two self-locking nuts and take the pinion bearing oil nozzle from the aft side of the gearbox cover. Discard the O-ring seal. (See figure 3-47A.)
- b. Remove the torquemeter shaft support spanner nut using 6795597 wrench. (See figure 3-47B.) Remove the cup washer. Remove the torquemeter shaft support from the gearbox cover. Remove the headed pin; then press the bearing inner race from the support using 6796947 drift and 6796950 plate with detail -5. (See figures 3-47C and 3-47D.)
- c. Simultaneously remove the helical power takeoff gearshaft and the helical torquemeter gearshaft. Remove the helical torquemeter gearshaft bearing end plate and thrust washer. Discard O-ring from the gearbox cover.
- d. Remove the bearing outer race and rollers from the helical torquemeter gearshaft. Remove the damper ring from the helical torquemeter gearshaft.
- e. Remove the ball bearing from the helical power takeoff gearshaft using 6796948 drift and 6796950 plate with detail -11. (See figure 3-47C.) Remove the roller bearing inner race using 6796948 drift and 6796950 plate with detail -10.



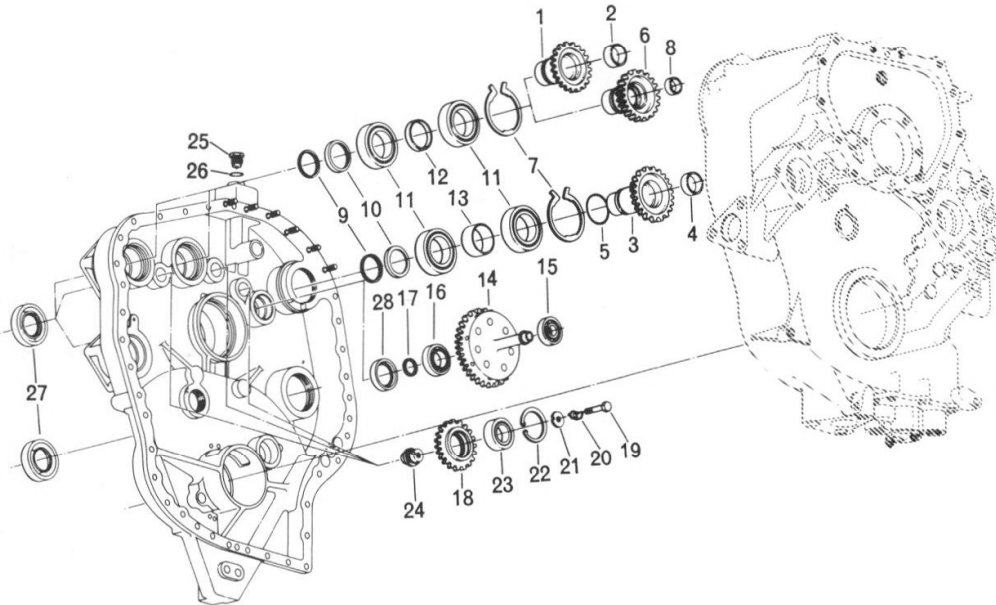
9077BX

- 1. Pinion bearing oil nozzle
- 2. Nut (2)
- 3. O-ring
- 4. Gearbox cover
- 5. Nut (36)
- 6. Bolt
- 7. Bolt
- 8. Washer (38)
- 9. Nut (3)
- 10. Washer (3)
- 11. Bolt (2)
- 12. Washer (2)
- 13. Spanner nut
- 14. Key washer

- 14A. Cup washer
- 15. Torquemeter shaft support
- 16. Pin
- 17. Power takeoff helical gearshaft
- 18. Roller bearing inner race
- 19. Ball bearing
- 20. Torquemeter helical gearshaft
- 21. Internal retaining ring
- 22. Roller bearing
- 23. Thrust washer
- 24. O-ring
- 25. Power train drive helical gear
- 26. Ball bearing (2)
- 27. Internal retaining ring

- 28. Bearing outer race and rollers
- 29. Fuel control spur gearshaft
- 30. Internal retaining ring
- 31. Pin
- 32. Splined adapter
- 33. O-ring
- 34. Retaining ring
- 35. Bearing retainer
- 36. Ball bearing (2)
- 37. Spacer
- 38. Identification plate
- 39. Screw (2)
- 40. Washer (2)

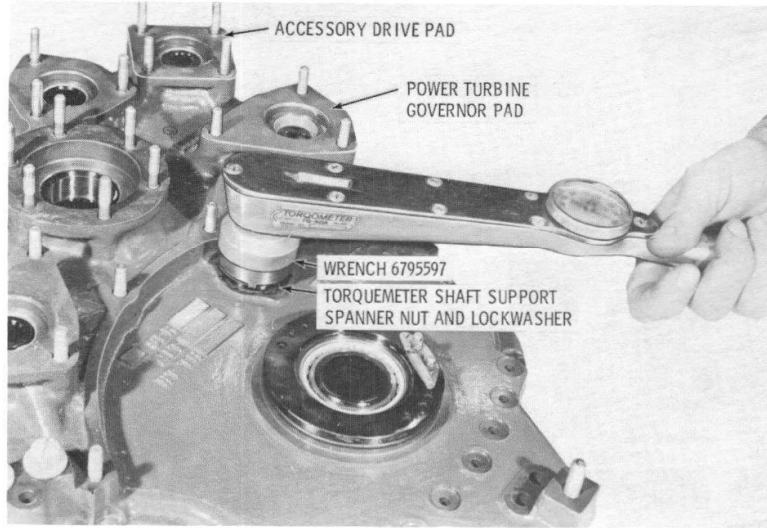
Figure 3-47A. Power and Accessories Gearbox Cover Assembly (Sheet 1 of 2)



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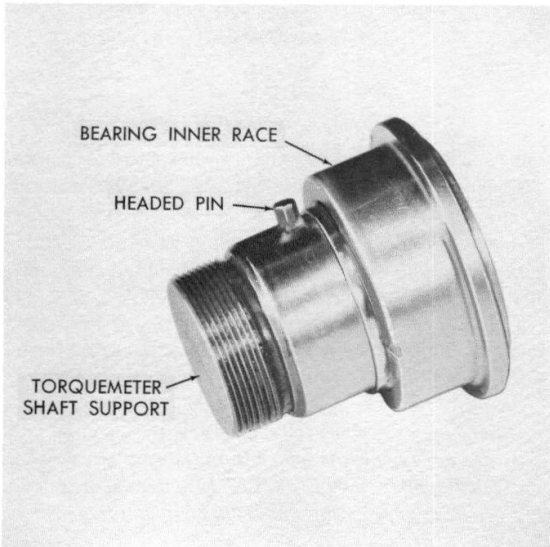
- |                                     |   |   |
|-------------------------------------|---|---|
| 1. Accessory drive spur gearshaft   | 11. Ball bearing (6)                        | 20. Key washer (3)                      |
| 2. Plug                             | 12. Gearshaft bearing sleeve spacer (2)     | 21. Bearing retaining keyway washer (3) |
| 3. Starter generator spur gearshaft | 13. Gearshaft bearing sleeve spacer         | 22. Internal retaining ring (3)         |
| 4. Plug                             | 14. Gas producer train idler spur gearshaft | 23. Ball bearing (3)                    |
| 5. O-ring                           | 15. Ball bearing                            | 24. Idler gear support shaft (3)        |
| 6. Fuel pump drive spur gearshaft   | 16. Ball bearing                            | 25. Plug                                |
| 7. Internal retaining ring (3)      | 17. Internal retaining ring                 | 26. O-ring                              |
| 8. Drilled plug                     | 18. Gas producer train idler spur gear (3)  | 27. Plain encased seal (4)              |
| 9. External retaining ring (3)      | 19. Bolt (3)                                | 28. Plain encased seal                  |
| 10. Bearing retainer (3)            |   |   |

Figure 3-47A. Power and Accessories Gearbox Cover Assembly (Sheet 2 of 2)



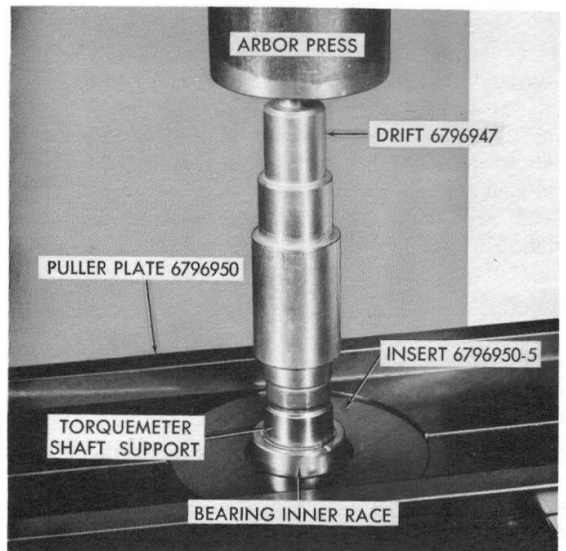
188746

Figure 3-47B. Removing or Installing Torquemeter Shaft Support Spanner Nut



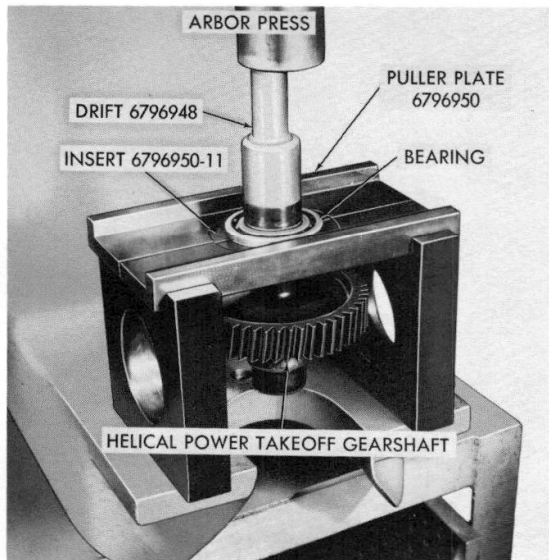
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Figure 3-47C. Torquemeter Shaft Support



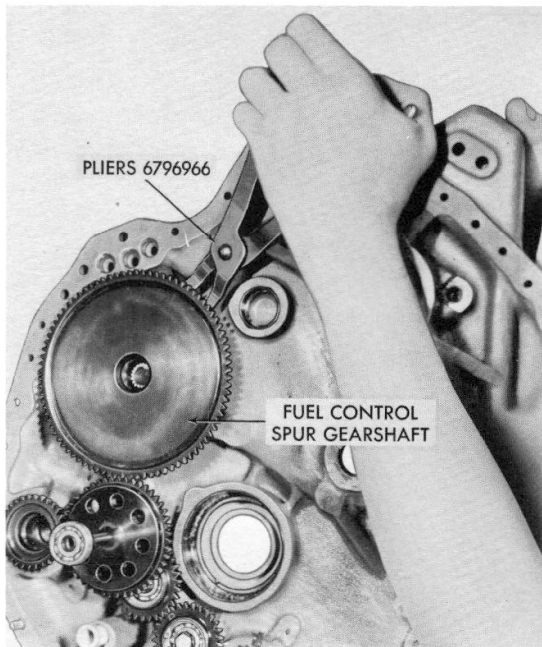
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Figure 3-47D. Removing Roller Bearing Inner Race from the Torquemeter Shaft Support



188757

**Figure 3-47E. Removing Ball Bearing from the Helical Power Takeoff Gearshaft**



188750

**Figure 3-47F. Removing Fuel Control Spur Gearshaft**

f. Remove the power train drive helical gear from the gearbox cover. Remove the two ball bearings (No. 3 and No. 4) from the gear using 6872746 puller with 6796948 drift. As an alternate use detail -23 of 6796950 puller kit with 6796948 drift. Discard any bearings which have been pulled by the outer race.

g. Remove the internal retaining ring and roller bearing (No. 2-1/2) from inside the helical drive gear.

----- **NOTE** -----

*Replace the No. 2-1/2 bearing if it must be pulled or driven from the helical drive gear.*

-----

h. Remove the fuel control spur gearshaft from the cover by removing the internal retaining ring with 6796966 retaining ring pliers. (See figure 3-47F.) Discard O-ring. Do not remove the pin or splined adapter from the gearshaft. Remove the external retaining ring and bearing re-

tainer. (See figure 3-47G.) Remove the two bearings and the bearing spacer from the shaft using 6796946 drift and 6796950 plate with detail -12.

i. Remove the accessory drive spur gearshaft (spare) from the gearbox cover by removing the internal retaining ring with 6796966 pliers. (See figures 3-47A, 2 of 2, and 3-47H.) Remove the external retaining ring and bearing retainer. Remove the bearings and spacer from the shaft using 6796946 drift and 6796950 plate with detail -12.

----- **NOTE** -----

*Do not remove the plugs from the spur gearshafts unless they are loose. If replacement is necessary, press out plugs with a 5/8 in. (16 mm) OD drift.*

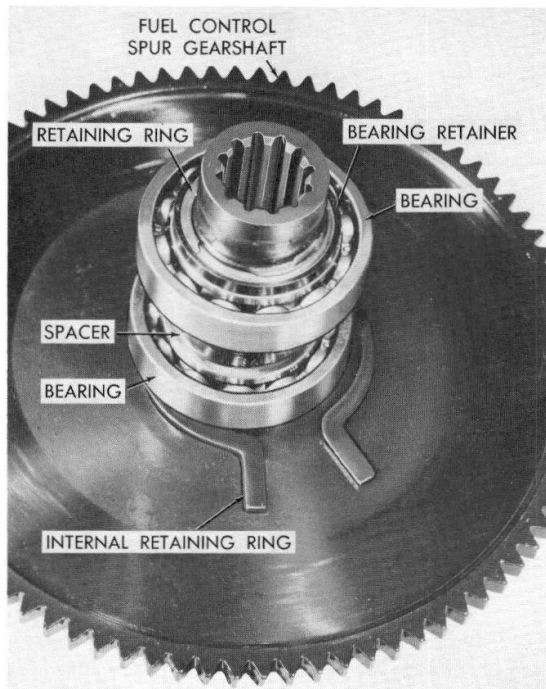
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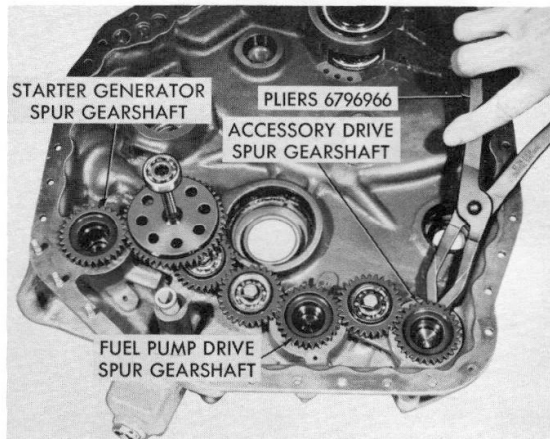
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**Figure 3-47G. Fuel Control Spur Gearshaft Components**

j. Remove the starter generator spur gearshaft from the gearbox cover by removing the internal retaining ring with 6796966 pliers. (See figure 3-47H.) Discard O-ring. Remove the external retaining ring and bearing retainer. Remove the bearings and spacer from the shaft using 6796946 drift and 6796950 plate with detail -12.

k. Remove the fuel pump drive spur gearshaft from the gearbox cover by removing the internal retaining ring with 6796966 pliers. (See figure 3-47H.) Remove the external retaining ring and bearing retainer. Remove the bearings and spacer from the shaft using 6796946 drift and 6796950 plate with detail -12.

l. Unlock the key washers and remove the two exposed bolts, key washers, and washers from the gas producer train idler spur gears. Remove the two gears and



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**Figure 3-47H. Removing or Installing Accessory Drive Spur Gearshaft**

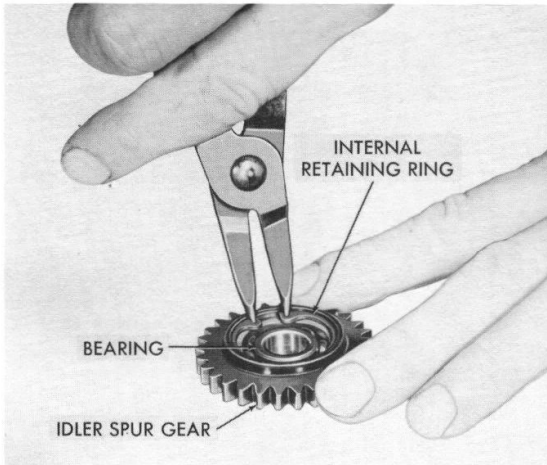
bearings from the idler gear support shafts. Remove the bearings from the idler gears by removing the internal retaining rings. (See figure 3-47 I.)

m. Unlock the keywasher of the gas producer train idler spur gear beneath the gas producer train idler spur gearshaft. Remove the idler spur gear bolt, washer, and key washer as the gas producer train idler spur gearshaft is being lifted out. Remove the internal retaining ring. Remove the bearing from the cover end of the gearshaft using 6796946 drift and 6796950 plate with detail -8. Remove the bearing from the housing end of the gearshaft using 6796946 drift and 6796950 plate with detail -13. Remove the gear and bearing from the idler gear support shaft. Remove retaining ring and separate bearing from gear.

n. Remove the three idler gear support shafts from the gearbox cover using 6795614 puller and pusher. (See figure 3-47J.)

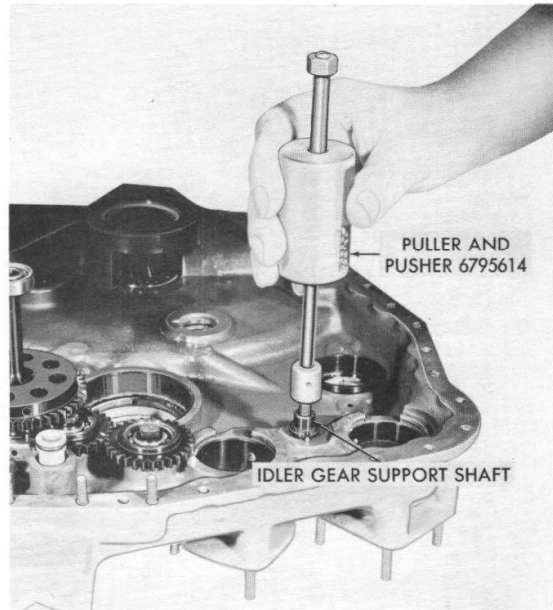
o. Remove the plug and O-ring from the gearbox cover. Discard O-ring.

p. Use 6796941 seal replacement kit to replace defective gearbox cover seals.



188756

**Figure 3-47 I. Removing or Installing Idler Spur Gear Retaining Ring**



188755

**Figure 3-47J. Removing or Installing Idler Spur Gear Support Shaft**

3-170E. Gearbox Housing Disassembly.

3-170F. Disassemble the gearbox housing as follows:

a. Remove the fuel control and oil pump spur gearshaft. (See figure 3-47K.) Remove the bearings using 6796946 drift and 6796950 plate with details -13 and -14. Rotate bearings during removal to avoid brinelling the raceways.

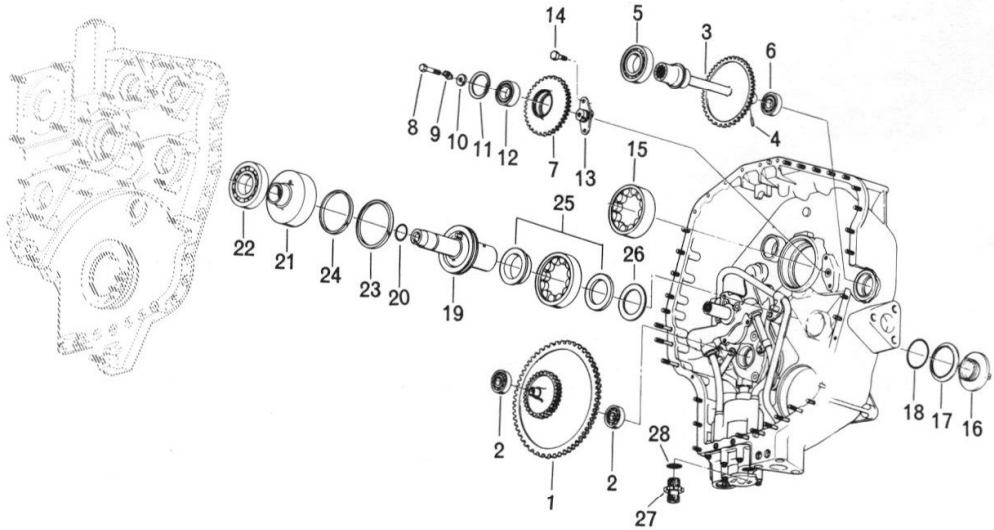
b. Remove the tachometer and governor power train spur gearshaft. Remove the bearings using 6796946 drift and 6796950 plate with details -7 and -12. Do not remove the spring pin.

c. Unlock the key washer and remove the power train idler spur gear bolt, key washer, and keyway bearing retaining washer. Lift the gear and bearing from the idler gear support shaft. Remove two bolts then pull the shaft from the gearbox housing using 6795614 puller and

pusher. Remove the bearing from the gear by removing the internal retaining ring.

d. Lift the helical power takeoff gearshaft roller bearing outer race and rollers from the gearbox housing.

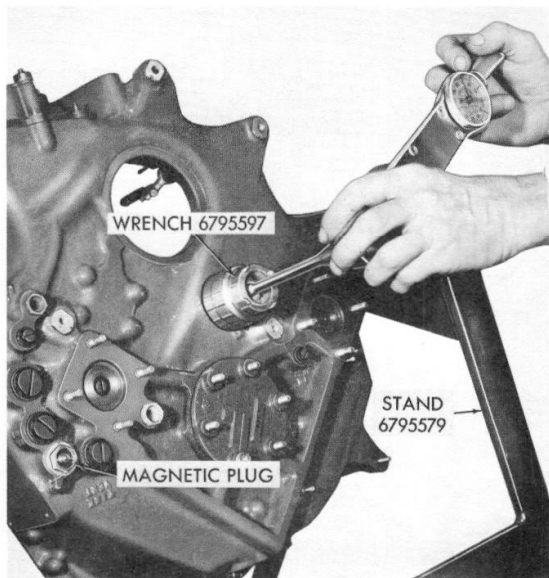
e. Remove lockwire then remove the torquemeter support shaft nut using 6795597 wrench and 6795974 aligning fixture. (See figures 3-47L and 3-47M.) Remove O-ring and washer. Discard the O-ring. Remove the shaft. Remove the torquemeter support shaft bearing end plate and washer from the gearbox housing. Remove and discard O-ring from the shaft. Remove piston and bearing from the shaft. Remove the expander and piston rings. Remove the ball bearing from the piston using 6796947 drift and 6796950 plate with detail -6. Remove the bearing outer race and rollers from the support shaft. Remove the bearing inner race from the support shaft using 6796947 drift and 6796950 plate with detail -4.



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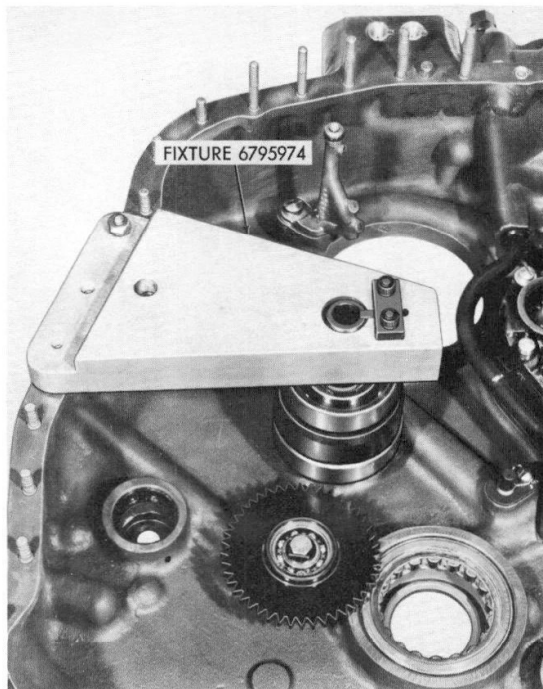
- |   |                                     |                        |
|---|-------------------------------------|------------------------|
| 1. Fuel control and oil pump spur gearshaft           | 10. Bearing retaining keyway washer | 20. O-ring             |
| 2. Ball bearing (2)                                   | 11. Internal retaining ring         | 21. Torquemeter piston |
| 3. Tachometer and governor power train spur gearshaft | 12. Ball bearing                    | 22. Ball bearing       |
| 4. Pin  | 13. Idler gear support shaft        | 23. Piston ring        |
| 5. Ball bearing                                       | 14. Bolt (2)                        | 24. Expander ring      |
| 6. Ball bearing                                       | 15. Roller bearing                  | 25. Roller bearing     |
| 7. Power train idler spur gear                        | 16. Torquemeter support shaft nut   | 26. Washer             |
| 8. Bolt   | 17. Internal flared washer          | 27. Magnetic plug      |
| 9. Key washer   | 18. O-ring                          | 28. O-Ring             |
|   | 19. Torquemeter support shaft       |                        |

Figure 3-47K. Power and Accessories Gearbox Housing Assembly



188762

**Figure 3-47L. Removing or Installing Torquemeter Support Shaft Spanner Nut**



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**Figure 3-47M. Torquemeter Support Shaft Aligning Fixture**

3-170G. Gearbox Housing Lubrication System Components.

3-170H. Disassemble the gearbox housing lubrication system components as follows:

a. Remove the two nuts and washers. Remove the oil filter cap. Separate the oil filter and O-rings from the filter housing. (See figure 3-47N, 1 of 2.) Discard the O-rings.

b. Remove the eight nuts and washers and lift the lube oil filter housing from the gearbox housing. Discard the gasket.

c. Remove the lockwire and remove the pressure regulator components from the filter housing. These components are:

(1) poppet guide, (2) O-ring, (3) spring, and (4) poppet.

d. Remove the lockwire and separate the magnetic drain plug from the lube oil filter housing. Discard the O-ring.

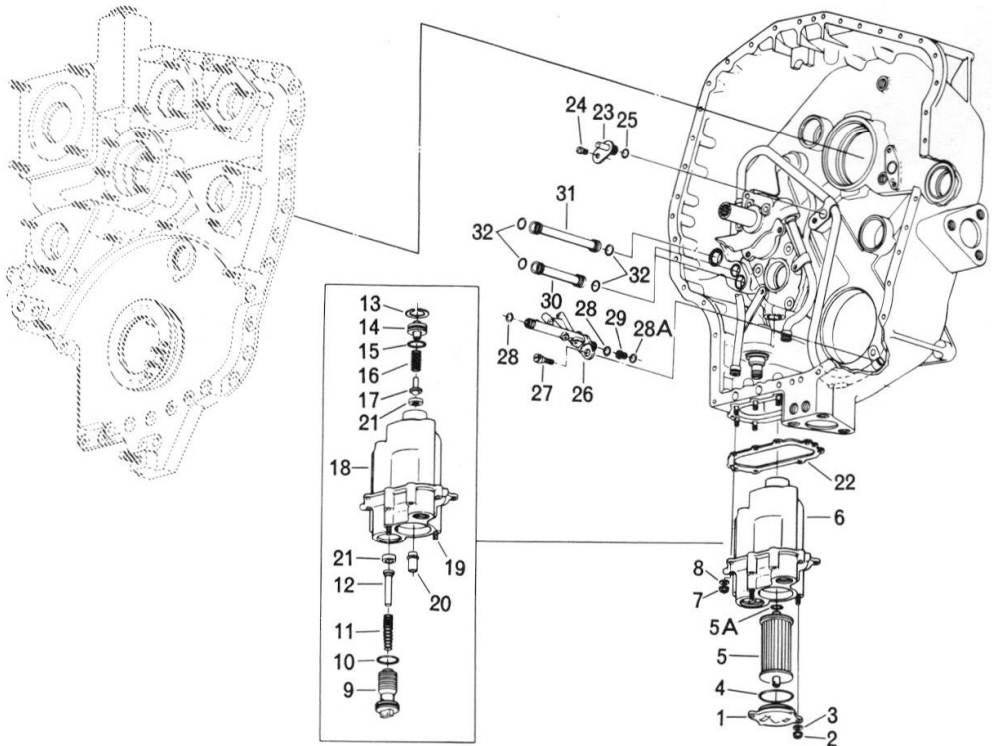
e. Remove the internal retaining ring and the filter bypass components from the filter housing. These components are: (1) poppet guide, (2) O-ring, (3) spring, and (4) poppet.

----- **NOTE** -----  
*Do not remove the studs, standpipe or two valve seats.*  
-----

f. Remove the screw and separate the oil pressure tube from the gearbox housing. Discard the O-ring.

g. Remove the screw and separate the oil delivery tube from the gearbox housing. Remove the screen and discard the three O-rings.

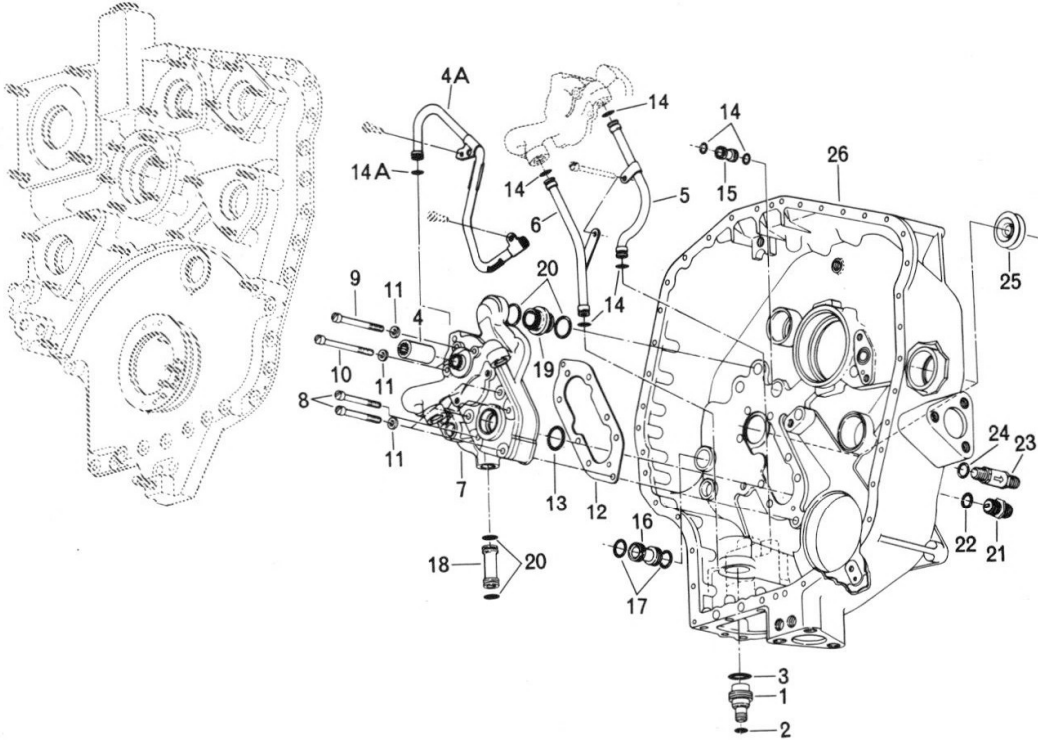
h. Remove the three oil transfer tubes. Discard two O-rings from each tube.



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- |  |                                      |                           |
|--|--------------------------------------|---------------------------|
| 1. Oil filter cap                        | 12. Pressure regulator valve poppet  | 23. Oil pressure tube     |
| 2. Nut (2)                               | 13. Internal retaining ring          | 24. Screw                 |
| 3. Washer (2)                            | 14. Filter bypass valve poppet guide | 25. O-ring                |
| 4. O-ring                                | 15. O-ring                           | 26. Oil delivery tube     |
| 5. Lube oil filter                       | 16. Helical compression spring       | 27. Screw                 |
| 5A. O-ring                               | 17. Valve poppet                     | 28. O-ring (2)            |
| 6. Lube Oil filter housing               | 18. Lube oil filter housing          | 28A. O-ring               |
| 7. Nut (8)                               | 19. Stud (2)                         | 29. Pressure oil screen   |
| 8. Washer (8)                            | 20. Oil filter standpipe             | 30. Oil transfer tube (2) |
| 9. Pressure regulator valve poppet guide | 21. Filter bypass valve seat (2)     | 31. Oil transfer tube     |
| 10. O-ring                               | 22. Filter housing gasket            | 32. O-ring (6)            |
| 11. Helical compression spring           |                                      |                           |

Figure 3-47N. Gearbox Housing Lube System Assembly (Sheet 1 of 2)



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- |  |                               |   |
|--|-------------------------------|---|
| 1. Check valve                                   | 10. Screw (2)                 | 18. Oil transfer tube                     |
| 2. O-ring  | 11. Washer (6)                | 19. Oil transfer tube                     |
| 3. O-ring  | 12. Lube oil pump gasket      | 20. O-ring (4)                            |
| 4. Fuel control and oil pump flex shaft coupling | 13. O-ring                    | 21. Magnetic plug                         |
| 4A. Scavenge oil tube                            | 14. O-ring (6)                | 22. O-ring                                |
| 5. Oil filter inlet tube                         | 14A. O-ring                   | 23. Low pressure scavenge oil check valve |
| 6. Oil filter bypass tube                        | 15. Oil transfer tube         | 24. O-ring                                |
| 7. Lube oil pump                                 | 16. Oil pump supply connector | 25. Plain encased seal (2)                |
| 8. Screw (5)                                     | 17. O-ring (2)                | 26. Power and accessories gearbox housing |
| 9. Screw   |                               |   |

Figure 3-47N. Gearbox Housing Lube System Assembly (Sheet 2 of 2)



i. Remove the check valve. (See figure 3-47N, 2 of 2.) Remove and discard the two O-rings. Do not disassemble the check valve.

j. Remove the fuel control and oil pump flex shaft coupling.

k. Remove the eight pump attaching screws and six washers. Remove the oil filter inlet and bypass tubes, the transfer tube to the filter housing, and the scavenge oil tube. Discard the seven O-rings. Remove pump. Discard the gasket and O-ring beneath the pump.

l. Remove the two oil transfer tubes and the connector beneath the oil pump. Discard two O-rings from each.

m. Remove the lockwire and separate the magnetic plug from the gearbox housing. Discard O-ring.

n. Remove the low pressure scavenge check valve from the gearbox housing. Discard O-ring.

o. Remove gearbox housing accessory pad seals using 6796941 seal replacement kit only if the seals are defective.

### 3-170H.a. Oil Pump.

3-170H.b. Disassemble and inspect the oil pump when it is the suspected cause of oil pressure and/or oil scavenging discrepancies. (Remove pump in accordance with the Gearbox Housing Lubrication System Components paragraph. Install pump in accordance with the Gearbox Housing Assembly paragraph.)

3-170H.c. Disassemble the lube pump as follows: (See figure 3-47N.a.)

a. Remove two screws and use a prying tool to separate the pressure oil pump body from the balance of the pump.

----- **CAUTION** -----

*Be careful not to pry on, or damage, any lapped surfaces.*

-----

b. Remove the oil pump idler spur gear. Remove and discard the O-ring in the pump body. Do not remove the pinned bushing, cage or flanged bushings unless replacement is required.

c. Remove the oil pump and gas producer tachometer spur gearshaft. Do not remove the oil seal plug unless it is loose. If replacement is necessary, press out the plug using ¼-in. (6 mm) OD drift.

d. Remove the pressure and scavenge oil pump separator body using a prying tool. Do not pry on lapped surfaces. Remove the oil pump drive spur gear and three oil pump idler spur gears. Discard five O-rings.

e. Remove the scavenge oil pump cover from the scavenge oil pump body using a prying tool. Do not pry on lapped surfaces. Remove the oil pump drive spur gear and three oil pump idler spur gears. Discard three O-rings.

f. Do not remove the four dowel pins from the pump body unless replacement is necessary. Do not remove the three pinned oil pump gearshafts or the pinned bushing from the scavenge oil pump cover unless replacement is necessary.

3-170H.d. Inspect the components of the oil pump in accordance with table III-9C.

3-170H.e. Assemble the lube oil pump as follows (See figure 3-47N.a.)

----- **CAUTION** -----

*Use only specified lubricants during pump assembly; do not use silicone lubricants.*

-----

a. Lubricate and install the three O-rings in the scavenge body assembly. Install the oil pump drive gear and three oil pump idler gears.

----- **NOTE** -----

*Measure the gear end clearance in the pressure and scavenge elements between the splitline and gear end with a dial indicator. The gear end clearance must be 0.001–0.0015 in. (0.03–0.038 mm). If the end clearance limit is exceeded, replace the pump.*

-----

b. Place cover assembly on the scavenge body assembly. Install oil pump drive gear with lubricated O-ring and three oil pump idler gears. Lubricate and install four O-rings in the separator body. Place separator body on the scavenge body assembly.

c. Install oil seal plug in oil pump and gas producer tachometer spur gearshaft if it has been removed. Install oil pump idler spur gear and oil pump and gas producer tachometer spur gearshaft on the separator body.

d. Lubricate and install O-ring in pressure oil pump body. Place pressure oil pump body on scavenge body assembly. Install two screws, tighten to 18-22 lb in. (2.03-2.49 N·m).

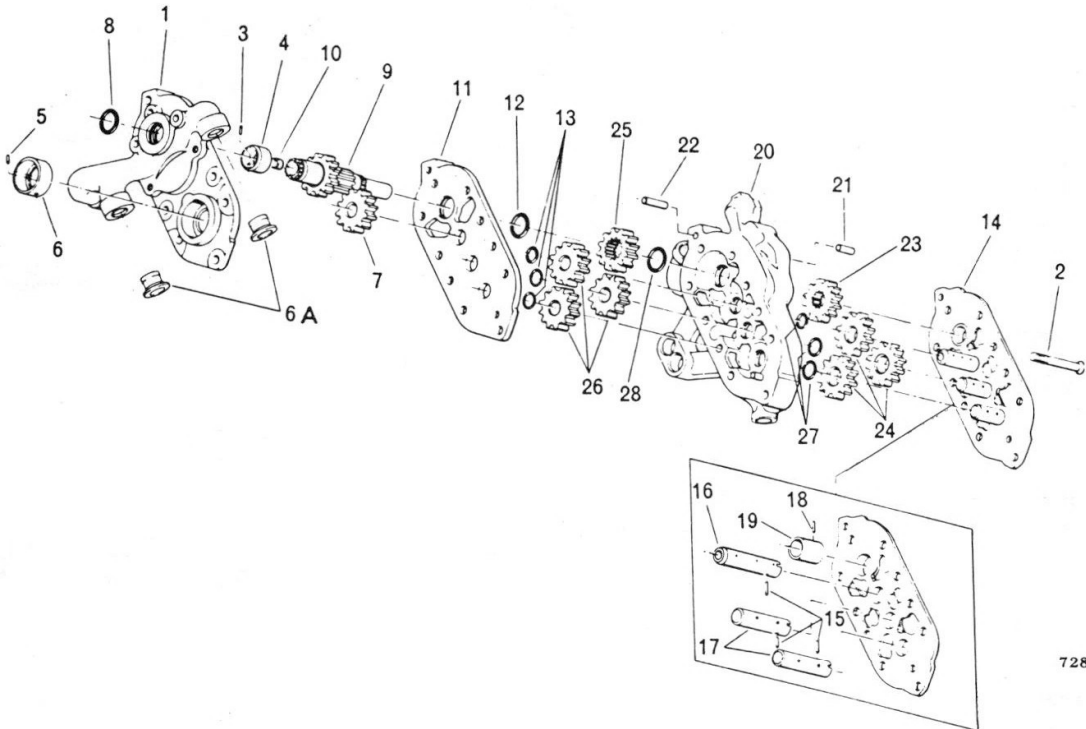
3-170I. Assemble the gearbox as follows:

3-170J. Lube Oil Filter Housing Assembly. (See figure 3-47N, 1 of 2.)



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- |  |                                      |
|--|--------------------------------------|
| 1. Pressure oil pump body                              | 14. Studding scavenge oil pump cover |
| 2. Screw (2)   | 15. Pin (3)                          |
| 3. Pin   | 16. Oil pump gear shaft              |
| 4. Sleeve bushing                                      | 17. Oil pump gear shaft (2)          |
| 5. Pin   | 18. Pin                              |
| 6. Plain bearing cage                                  | 19. Bushing                          |
| 6A. Flanged bushings (2)                               | 20. Scavenge oil pump body           |
| 7. Oil pump idler spur gear                            | 21. Pin (2)                          |
| 8. O-ring  | 22. Pin (2)                          |
| 9. Oil pump and gas producer tachometer spur gearshaft | 23. Oil pump drive spur gear         |
| 10. Oil seal plug                                      | 24. Oil pump idler spur gear (3)     |
| 11. Pressure and scavenge oil pump separator body      | 25. Oil pump drive spur gear         |
| 12. O-ring   | 26. Oil pump idler spur gear (3)     |
| 13. O-ring (3)   | 27. O-ring (3)                       |
|  | 28. O-ring                           |

Figure 3-47N.a. Oil Pump Assembly

3-170K. Assemble and test the lube oil filter housing as follows:

- a. Install the poppet, spring, lubricated O-ring, and guide in the filter housing. Retain with an internal retaining ring. Use 6798807 compressor to aid in installation of retaining ring.

----- **CAUTION** -----

*Inspect the retaining ring before installation to be sure it has no defects and after installation to be sure it is properly seated.*

-----



TABLE III-9C

<b>Oil Pump Inspection Limits</b>				
<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
<u>Oil Pump Body, Separator, and Cover (1, 11, 14, 20, fig. 3-47N.a.)</u>				
1	Cracks (FPI).	None.		Replace pump.
2	Wear of gear pockets.	Max of 0.005 in. (0.13 mm).		Replace pump.
3	Gear end clearance.	0.001-0.0015 in. (0.03-0.038 mm)		Replace pump.
<u>Oil Pump Gears</u>				
4	Cracks in radii root corners of spline teeth or in line or parallel in close proximity on involute of a gear tooth side (visual with magnification).	None.		Replace pump.
5	Nonmetallic inclusion on small gears and gearshafts.	Light scattered inclusions parallel to material flow lines.  Open inclusion on shaft $\frac{3}{8}$ in. (10 mm) max length and not extending into a radius hole or spline root.		Replace pump.  Replace pump.
6	Nicks and dents.	Max of 0.010 in (0.25 mm) length, width or dia and without sharp corners.	Max of 0.060 in. (1.52 mm) length, width or dia after sharp corners are removed.	Remove sharp edges by stoning.
7	Tooth damage which involves metal displacement to a degree where subsurface damage is detected by magnetic inspection.	None.		Replace pump.
8	Scuffing.	Scuffing when accompanied by wear-off of metal pickup if gear assembly is still matched with mating gears.	Scuffing evidenced by pickup.	Remove sharp edges by stoning.





TABLE III-9C (cont)

<i>Item</i>	<i>Condition</i>	<i>Serviceable Limit</i>	<i>Repairable Limit</i>	<i>Disposition</i>
<u>Oil Pump and Gas Producer Tachometer Spur Gearshaft (9, fig 3-47N.a.)</u>				
9	Seal Journal wear.	Max of 0.0015 in. (0.038 mm) radial wear on dia.		Replace pump.
10	Spline wear.	Max of 0.002 in. (0.05 mm) wear measured from adjacent unworn area.		Replace pump.
11	Scoring, grooves, nicks, gouges, scuffing or minute flats on shaft seal journal surfaces.	Evenly polished surface in seal contact without lead or axial marking.		Replace pump.
<u>Pump Bushings, Gear Shafts, and Dowel Pins</u>				
12	Loose or bent dowel pins.	None.		Replace pump.
13	Wear on ID of pump bushings.			Replace pump.

b. Lubricate and install the O-ring on the pressure regulator guide. Insert poppet, spring, and guide into the filter housing. Make an approximate adjustment of the regulator by bottoming the adjusting screw and backing out 5½ turns.

c. Test the lube oil filter housing as follows:

- (1) Plug the standpipe and install the cap on the filter housing.
- (2) Connect a supply of calibration fluid at 75-85°F (24-29°C) or engine oil at 80-100°F (27-38°C) to the filter housing inlet port.
- (3) Slowly apply increasing pressure until the bypass valve opens. Pressure must be 80-130 psig.
- (4) Decrease pressure to 30 psig. Leakage through the bypass valve must not exceed 63 cc per minute.
- (5) Connect the fluid supply to the outlet port and plug the inlet port.
- (6) Adjust the fluid supply to obtain a flow of 720 pph across the filter.
- (7) Adjust the guide assembly until 130 ± 5 psig is obtained with 720 pph flow.
- (8) Decrease flow to 15 pph. Pressure must not be less than 125 psig. If pressure is not within limits, repeat steps (6) and (7), while adjusting the guide assembly for a

higher pressure within the 130 ± 5 psig range. If pressure is less than 125 psig at 15 pph, replace the pressure regulating poppet valve and repeat the entire test.

(9) Remove the cap and remove the plug from the standpipe. Remove the plug from the inlet port.

d. Install the filter assembly with O-ring in the filter housing. Install the cap with lubricated O-ring on the filter housing. Secure the cap with two nuts and washers. Tighten nuts to 35-40 lb in.

3-170K. Gearbox Housing Assembly. (Refer to figure 3-47K.)

3-170L. Assemble the gearbox housing as follows:

a. Install gearbox housing seals as necessary at the following locations using 6796941 seal installation kit with details -16 or -19. (See figures 3-47 and 3-47P.) Apply grease to the seal lip to aid in installation.

(1) Power turbine tachometer generator pad (use detail -16)

(2) Gas producer tachometer generator pad (use detail -16)

Figure 3-47 O deleted.

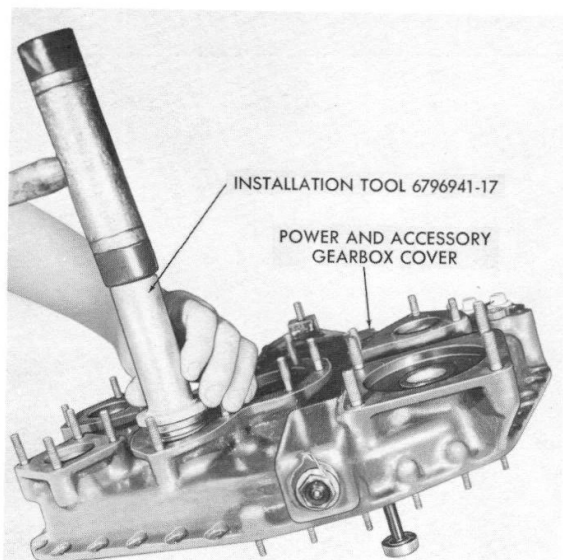


Figure 3-47P. Typical Seal Installation

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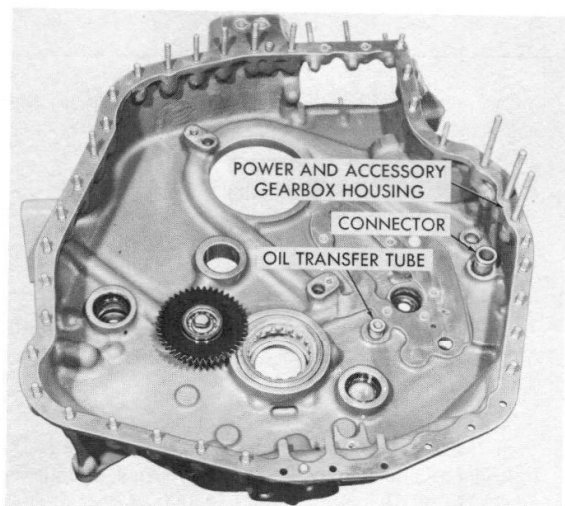


Figure 3-47Q. Oil Transfer Tubes in Gearbox Housing

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b. Lubricate and install O-rings on each end of the two oil transfer tubes and the connector which go beneath the oil pump. Install the transfer tubes and connector in the gearbox housing. (See figure 3-47Q.)

c. Lubricate and install two O-rings on oil transfer tube and insert tube in the pump. (See figure 3-47N, 2 of 2.)

d. Lubricate and install the O-ring on the underside of the lube pump. (See figure 3-47N, 2 of 2.) Position the pump mounting gasket and install the pump in the gearbox housing using 6796941 seal guide with detail -13. Install the filter inlet and filter bypass tubes with lubricated O-rings. Insert eight-pump attaching screws with six washers. Washers are used at positions 1, 3, 4, 5, 6, and 7 counting clockwise with 1 at the point nearest the filter housing. The five 10-32 x 2 in. screws go at positions 1, 2, 3, 7, and 8; the two 10-32 x 2.750 in. screws go at positions 4 and 6; the 10-32 x 2.375 in. screw goes at position 5. Do not tighten screws at positions 2 and 8 at this time, tighten others finger tight.

e. Lubricate O-ring and install it on the scavenge oil tube. Install the scavenge oil tube in the oil pump. Retain the scavenge oil tube with a screw at the oil pressure tube and with a screw at the oil delivery tube.

f. Lubricate and install the two O-rings on the check valve; install the valve in the gearbox housing.

g. Lubricate O-rings and install with low pressure scavenge oil check valve and with magnetic plug on outside of gearbox housing. Tighten magnetic plug to 60-80 lb in. (6.78-9.04 N-m) and secure with lockwire. Install check valve with arrow pointing away from gearbox housing.

h. Apply lubricant lightly to the splines then install the fuel control and oil pump flex shaft coupling in the oil pump.

i. Position the gasket and install the filter housing assembly in the gearbox housing. (See figure 3-47N, 1 of 2.) Mate the filter inlet and filter bypass transfer tubes and check valve to the filter housing during the assembly. Retain the housing with eight nuts and washers. Tighten nuts to 35-40 lb in. (3.95-4.52 N-m). Align the two tubes then tighten the pump attaching screws to 35-40 lb in. (3.95-4.52 N-m) and secure with lockwire.

j. Lubricate and install two O-rings on each of the three oil scavenge transfer tubes; install the short tubes in the pump and the long tube in the gearbox housing.

k. Lubricate and install two O-rings on the oil delivery tube and one O-ring on the oil pressure tube. Install the oil pressure tube (nozzle) and the oil delivery tube with screen in the gearbox housing. Retain each with a screw; tighten screws to 22-26 lb in. (2.49-2.94 N-m) and secure with lockwire.



1. Make a static leak check of the oil filter housing and lube oil pump assembly.

(1) Equipment. A six foot length of one-inch ID copper tubing having a length of hose with a shutoff valve near the outlet end; a four foot head of oil in the stand pipe; and a fitting for connecting the hose to the oil-in port of the gearbox.

(2) Attach the fitting to the gearbox and the stand-pipe hose to the fitting. Keep the hose coupling loose until the system can be bled. Open the shutoff valve and bleed the air from the system, then tighten the hose coupling nut.

(3) Place the gearbox housing in a vertical position with the oil pump at the top.

(4) Visually check the partial assembly for oil leakage over a period of ten minutes.

----- **NOTE** -----

*Leakage will be evident if a problem exists. Slight moistness or seepage should not be interpreted as leakage.*

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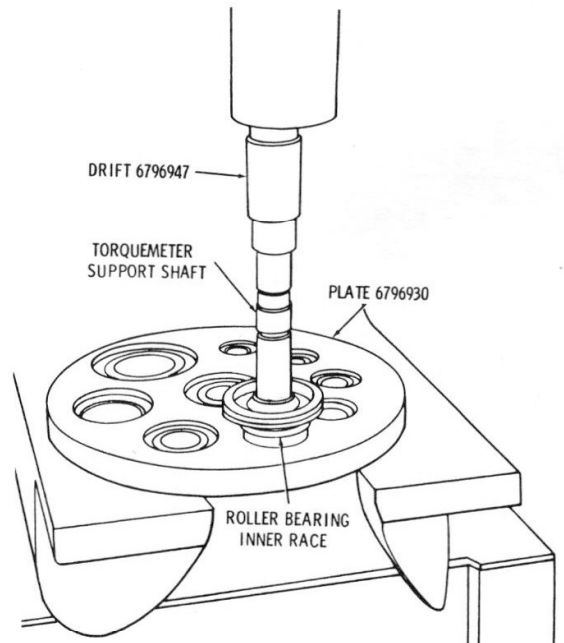
(5) Correct the condition causing leakage before proceeding with the assembly of the gearbox.

m. Install the helical power takeoff bearing outer race and rollers in the gearbox housing. **DO NOT** apply petrolatum or grease to the rollers. Lubricate using engine oil only.

n. Install the idler gear support shaft in the gearbox housing using 6795614 pusher and puller. Attach with two bolts. Secure with lockwire.

o. Lubricate and install the bearing in the power train idler spur gear, retain with an internal retaining ring. Install the gear and bearing on the shaft. Apply Loctite No. 242 lightly to the bolt threads; then retain the gear assembly on the shaft with the bolt, a keywasher and a keyway bearing retaining washer. Tighten bolt to 35-40 lb in. and bend locktab.

p. Install the bearing inner race on the torquemeter support shaft. Install with the thrust flange toward the torquemeter piston using 6796930 plate, location D, and 6796947 drift. (See figure 3-47R.) Apply a thin coat of petrolatum to the bearing and assemble the bearing outer race and rollers on the shaft. Install the bearing end plate and washer on the shaft. Lubricate and install the ex-



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**Figure 3-47R. Torquemeter Support Shaft Bearing Installation**

pander ring and piston ring in the torquemeter support shaft piston ring groove. The gap of the ring shall be 180° removed from the gap of the expander ring.

q. Lubricate and install the ball bearing on the torquemeter piston using 6796930 plate, location J and 6796947 drift. Install with the wide portion of the outer race away from the torquemeter piston. Install the piston on the torquemeter support shaft. Lubricate the O-ring and place it on the shaft.

r. Install the torquemeter support shaft in the gearbox housing. (See figure 3-47K.) Install 6795974 aligning fixture. (See figure 3-47M.) Install the internal flared washer and lubricated O-ring on the shaft. Tighten the nut using 6795597 wrench to 275-300 lb in. and secure with lockwire. (See figure 3-47L.)

s. Lubricate and install the bearings on the tachometer and governor power train spur gearshaft using 6796930 plate, locations C and G and 6796946 drift.

t. Apply lubricant lightly to the splines then install the tachometer and governor spur gearshaft in the gearbox housing using 6796941 seal guide with detail -13.



Figure 3-47 S deleted.

u. Lubricate and install the bearings on the fuel control and oil pump spur gearshaft using 6796930 plate, location H and 6796946 drift. The small ball bearing that was pulled by the outer race must be replaced with a new bearing at this step if there is any apparent indication of raceway brinelling. Install the gearshaft in the oil pump bearing cage.

3-170M. Gearbox Cover Assembly.

3-170N. Assemble the gearbox cover as follows:

a. Install gearbox cover seals as necessary at the following locations using 6796941 seal installation kit with details -16, -17, and -20. (See figures 3-47 and 3-47P.) Apply grease to the seal lip to aid in installation.

- (1) Gas producer fuel control pad (use detail -17)
- (2) Fuel pump pad (use detail -17)
- (3) Accessory drive pad (use detail -17)
- (4) Starter generator pad (use detail -18)
- (5) Gas producer idler spur gearshaft (internal installation held by a retaining ring) (use detail -20).

b. Install the three idler gear support shafts in the gearbox cover using 6795614 pusher and puller. (See figure 3-47J.) Lubricate and install the bearings in the three gas producer gear train idler spur gears, retain with internal retaining rings. (See figure 3-47 I.) Install two idler spur gears and bearings on the idler shafts. Retain the two gear assemblies with bearing retaining washers, key washers and bolts which have been lightly coated with Loctite No. 242. (See figure 3-47A, 2 of 2.)

c. Lubricate and install the ball bearings on the gas producer gear train idler spur gearshaft using 6796946 drift and 6796930 plate, locations F and H.

d. Install the third idler spur gear, bearing retaining washer, key washer and bolt at the same time the gas producer gear train idler spur gearshaft is installed. Coat the bolt threads lightly with Loctite No. 242 before installation.

Tighten the three bolts that retain the idler gears to 35-40 lb in. and bend locktabs of the keywashers.

e. Install the internal retaining ring then lubricate and install the two ball bearings, one at a time, and the bearing sleeve spacer on the accessory drive spur gearshaft using 6796949 drift and 6796930 plate, location C. Install the bearing retainer and secure it with an external retaining ring. Apply lubricant to the splines of the gearshaft and using 6796941 seal guide with detail -14, install the gearshaft in the gearbox cover. Secure with an internal retaining ring using 6796966 pliers.

f. Install the fuel pump drive spur gearshaft in the same manner that the accessory drive spur gearshaft was installed (step e).

g. Lubricate O-ring and install it on the starter-generator spur gearshaft. Assemble and install the starter-generator spur gearshaft in the same manner as the accessory drive spur gearshaft (step e).

h. Lubricate O-ring and install with plug at the top of the gearbox cover. Tighten plug to 60-80 lb in. and secure with lockwire.

i. Lubricate O-ring and install it on the fuel control spur gearshaft. Assemble and install the fuel control spur gearshaft in the same manner as the accessory drive spur gearshaft (step e). (See figure 3-47A, 1 of 2.)

j. Install the roller bearing in the helical power train drive gear. Secure with an internal retaining ring. Install the two ball bearings on the drive gear using 6796948 drift and 6796930 plate, location A. The bearings shall be selected to obtain an internal clearance of not less than 0.0003 in. after assembly on the gear. Check clearance using 6872165 gage. Chill the gear (-76°F max) and heat the bearings (250°F max) to aid in the installation. When bearings have cooled, lubricate bearings and install the gear in the gearbox cover.

k. Lubricate and install the ball bearing on the helical power takeoff gearshaft using 6796948 drift and 6796930 plate, location A. (See figure 3-47T.) Uniformly heat 350°-400°F) and install the roller bearing inner race on the gearshaft using 6796948 drift and 6796930 plate, location B. Hold the heated bearing race in position against the gear shoulder until heat distribution has normalized. Apply lubricant to the splines of the gearshaft and using 6796941 seal guide with detail -15, install the gearshaft in the gearbox cover.

l. Lubricate and install the O-ring in the groove at the torquemeter shaft opening of the gearbox cover. Lubricate and position the thrust washer and bearing end plate in the gearbox cover. Use petrolatum to retain the bearing outer race and rollers of the torquemeter bearing in the helical torquemeter gearshaft. Install the damper ring in



the retaining groove of the helical torque-meter gearshaft. Place the gearshaft in position in the cover, meshing the gear teeth with the teeth of the helical power train drive gear and the helical power takeoff gearshaft. Lubricate and install the roller bearing inner race on the torque-meter shaft support using 6796930 plate, location E and 6796947 drift. Install the headed pin in the shaft support. Install the shaft support in the cover through the gear using 6795969 holder. (See figure 3-47U.) Secure the support with a cup washer and spanner nut lightly coated with antiseize compound. Tighten spanner nut to 430-440 lb in. (48.58-49.71 N-m) using 6795597 wrench. (See figure 3-47B.) Crimp cup washer securely into lock nut slot.

m. Apply antiseize compound to the oil nozzle mounting studs; install oil nozzle with lubricated O-ring. Secure with two nuts. Tighten nuts to 35-40 lb in. (3.95-4.52 N-m).

3-1700. Gearbox Cover-to-Housing Assembly.

3-170P. Assemble the power and accessories gearbox cover to the housing as follows:

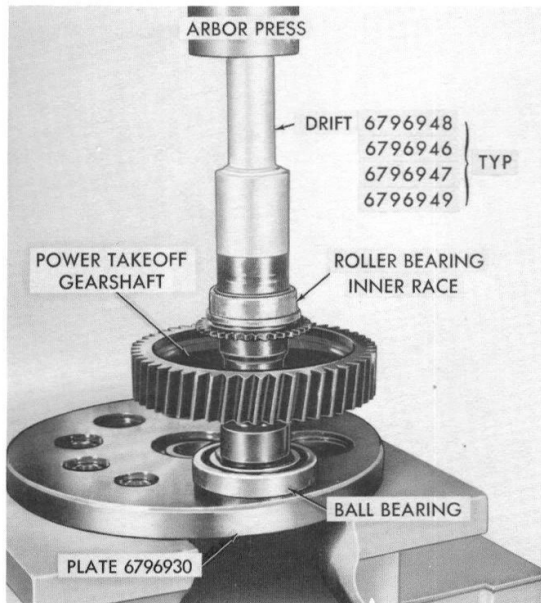
a. Apply a thin film of sealing compound (Scot Clad 776 or equivalent) to the gearbox housing splitline.

----- NOTE -----  
*A strand of dental floss (or equivalent), gently pressed into the Permatex around the splitline, will give added assurance against oil leaks.*  
-----

b. Install the 6886201 power takeoff roller bearing guide in the helical power takeoff gearshaft. (See figure 3-47V.) Install 6796941 seal guide, detail -14 in the tachometer and governor power train spur gearshaft. (See figure 3-47W.) Install 6895957 alignment tool over the oil tubes at the oil pump.

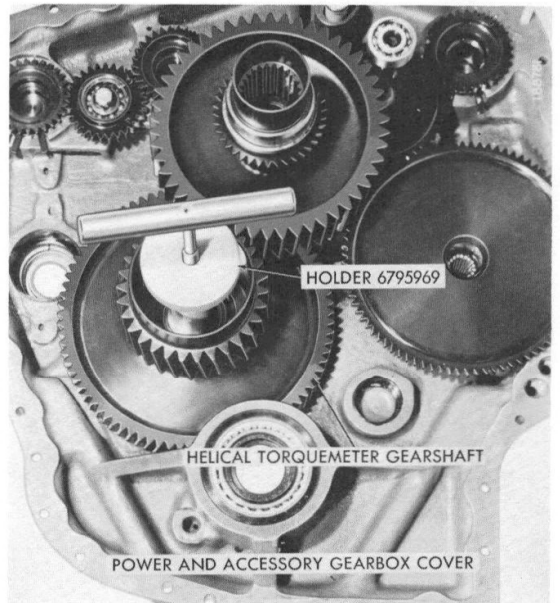
c. With the gearbox housing mounted in 6795579 stand and in a horizontal position, carefully assemble the gearbox cover to the gearbox housing, aligning the oil transfer tubes and the fuel control and oil pump flex shaft coupling. Insert 6799790 adapter in the tachometer and governor power train spur gearshaft. This may be used to turn the gear train to assist in assembly. Rotate the fuel control and oil pump spur idler gearshaft by hand to assure proper engagement with the fuel control spur gearshaft. Remove 6895957 alignment tool.

d. Apply antiseize compound lightly to the threads of studs and bolts used to attach the gearbox cover to the



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**Figure 3-47T. Power Takeoff Gearshaft Bearing Installation**



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**Figure 3-47U. Installing Torquemeter Shaft Support**



gearbox housing. The cover is secured by 39 nuts, 4 bolts, and 43 washers. (See figure 3-47A, 1 of 2.)

(1) Tighten the two 10-32 bolts to 20-25 lb in. (2.26-2.82 N-m).

(2) Tighten the 10-32 nuts to 35-40 lb in. (3.95-4.52 N-m).

(3) Tighten the ¼-28 nuts to 70-85 lb in. (7.91-9.60 N-m).

(4) Tighten the 5/16- 24 bolts to 120-150 lb in. (13.56-16.95 N-m) and secure with lockwire.

e. Check the operation of the power and control gear trains to ensure no binding is present between the meshing teeth.

(1) Turn the power train counterclockwise through the power turbine fuel governor pad. (See figure 3-47.) Use 6799790 adapter. No binding is acceptable.

(2) Turn the control gear train counterclockwise through the gas producer fuel control pad. (See figure 3-47.) Use 6799790 adapter. No binding is acceptable.

f. Remove the 6886201 power takeoff roller bearing guide from the helical power takeoff gearshaft. Install the gearbox housing seal in the power output pad (use detail -19). Lubricate the seal with engine oil prior to installation.

**3-171. PROPELLER REDUCTION GEARBOX REPLACEMENT.**

3-172. Remove the propeller reduction gearbox as follows:

a. Remove the beta control valve as follows:

(1) Remove the rod end cap, fitting and check nut from the beta control rod. (See figure 3-17.)

(2) Remove the beta valve cover from the aft side of the accessory gearbox.

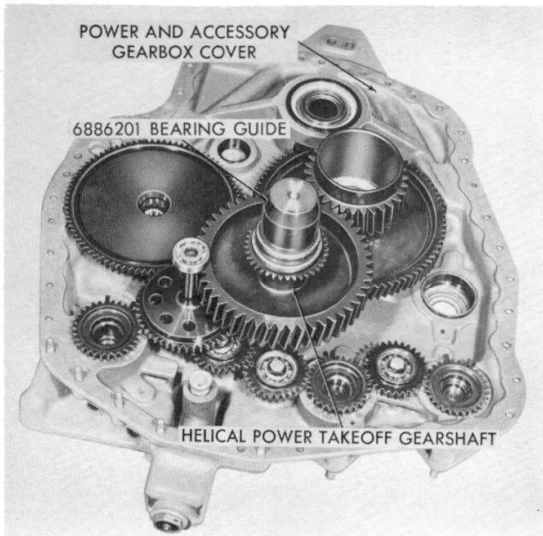
(3) Apply approximately 30 lb (133 N) force to the spring retainer and remove the internal retaining ring from the propeller mounting flange. Remove the beta valve.

b. Remove oil supply and scavenge tubes. Loosen the jam nut and remove the tee from the reduction gearbox.

c. Remove the propeller-power turbine governor. (Refer to Propeller-Power Turbine Governor Assembly, para 3-93.)

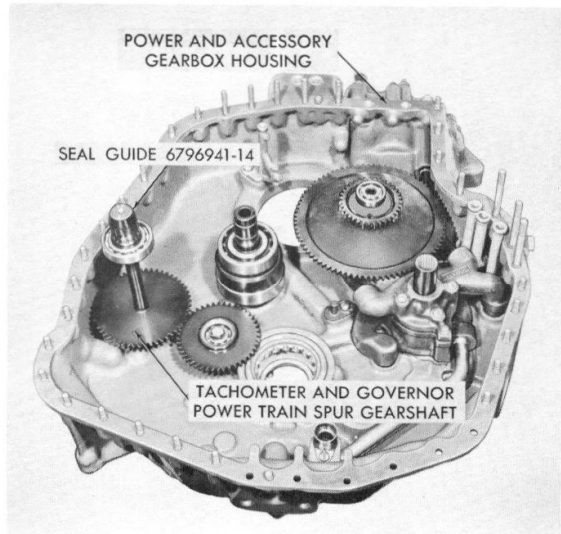
d. Remove the start counter and bracket.

e. Remove the propeller reduction gearbox by removing the remaining 10 bolts, 2 nuts and 12 washers at the split-line.



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Figure 3-47V. Seal Guide Location (Cover)



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Figure 3-47W. Seal Guide Location (Housing)



3-173. Install the propeller reduction gearbox as follows:

a. Install the propeller reduction gearbox on the power and accessories gearbox. Attach with 12 bolts, 2 nuts and 10 washers. Do not install washers at the No. 3 and No. 4 bolt positions (as viewed from the front of the engine). Tighten bolts to 35-40 lb in. (3.95-4.52 N-m); tighten two nuts to 70-85 lb in. (7.91-9.60 N-m). Lockwire the bolts in pairs.

b. Install the start counter and bracket. (Refer to the applicable portion of Ignition Exciter, para 3-124.)

c. Install the propeller-power turbine governor. (Refer to Propeller-Power Turbine Governor Assembly, para 3-93.)

d. Install the tee with new O-ring in the gearbox oil supply port. Install the oil supply tubes. Tighten the coupling nuts to 65-100 lb in. (7.34-11.30 N-m). Tighten the jam nut to 55-80 lb in. (6.21-9.04 N-m).

e. Install the scavenge oil tube. Tighten the coupling to 150-200 lb in. (16.95-22.60 N-m).

f. Install the beta control valve. (Refer to Beta Control Valve and Propeller Installation, para 3-109.)

g. Check run the engine after propeller reduction gearbox replacement. (Refer to Check Run, para 3-174.)

### 3-174. CHECK RUN.

### 3-175. OPERATING INSTRUCTIONS.

----- CAUTION -----

*Each time the propeller is serviced with grease, make a brief check run (approx. 5 min.) to be sure grease is not passing through the seal and being ingested into the engine. Wipe all grease from the hub and inlet areas before resuming operation.*

-----

3-176. Check run the engine in the airframe when the compressor assembly, compressor case, turbine assembly, combustion section, power and accessories gearbox, propeller reduction gearbox, fuel control, propeller-power turbine governor, propeller overspeed governor, fuel pump, fuel nozzle, or thermocouple has been removed, repaired or replaced. Purge the propeller oil system and subject the prop to a run cycle when the engine or the prop has been removed and replaced. Operate the engine in accordance with Operating Procedures, para 2-12. Make note of all incidents of the run such as leaks, abnormal vibration or noises, and/or any irregular functioning of engine equipment. Also note that the following items are within limits: (Refer to Operating Limits, para 2-3.)

a. Measured gas temperature. (See tables II-1, II-1A or II-2.)

b. Output shaft torque. (See table II-2.)

c. Oil pressure. (Refer to Oil Pressure and Temperature, para 2-10.)

d. Gas producer  $N_1$  speed. (Refer to Overspeed, para 2-4.)

e. Power turbine  $N_2$  speed. (Refer to Overspeed, para 2-4.)

### 3-177. DIFFUSER VENT ORIFICE SELECTION.

3-178. Select and install the diffuser vent orifice as follows:

a. Install a -7 size orifice on the diffuser vent tube. (See figure 3-48.)

b. Clean the area around the orifice.

c. Following the next flight of at least five minutes duration, inspect the area around the orifice. If there is any evidence of smoking or spewing from the vent, reduce the orifice size by installing the next lower dash number orifice.

----- CAUTION -----

*Do not install a smaller orifice (lower dash number) than that required to stop spewing or smoking at the vent.*

-----





d. Repeat the flight, inspection, and orifice replacement until no evidence of spewing or smoking is encountered.

e. As an alternate method for obtaining the desired orifice size, start with two -2 size orifices (No. 1 and No. 2).

(1) Drill out No. 1 orifice to 0.236-0.244 in. (5.994-6.198 mm). No. 1 orifice then becomes a -3 orifice. If No. 1 does not smoke when checked during engine operation, resize No. 2 orifice.

----- **NOTE** -----  
*When smoking is encountered, reinstall the previously drilled smaller orifice that did not smoke.*

(2) Drill out the No. 2 orifice to 0.266-0.274 in. (6.756-6.960 mm). No. 2 orifice then becomes a -4 orifice. If No. 2 does not smoke when checked during engine operation, resize No. 1 orifice.

(3) Drill out the No. 1 orifice to 0.296-0.304 in. (7.518-7.722 mm). No. 1 orifice then becomes a -5 orifice. If No. 1 does not smoke when checked during engine operation, continue alternately enlarging the No. 1 then the No. 2 orifice by one dash number size until the desired orifice is obtained.

f. Record the size of the finally selected orifice (by dash number) in the Engine Log.

**3-179. CHECK RUN SCHEDULE.**

3-180. Check run the engine in the airframe in accordance with the following schedule.

*Setting No. Condition*

1. Start engine and accelerate to Ground Idle  $N_1 = 59-65\%$ .  
Observe engine for abnormal conditions such as vibration, noise or leakage. Duration of run need not exceed five minutes.

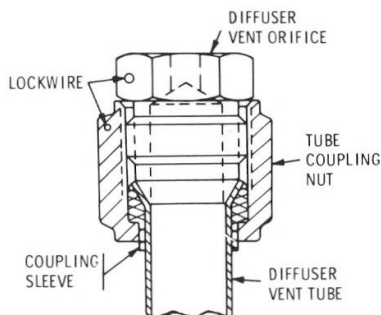


Figure 3-48. Diffuser Vent Orifice Installation.

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2. Shut down.
3. Start engine, accelerate and stabilize at Ground Idle.
4. Accelerate to 100% speed and minimum power. Stabilize for two minutes.
5. Reduce speed to Ground Idle.  
Check operation of anti-ice valve. Dwell for two minutes.
6. Shut down.

----- **NOTE** -----  
*Give the engine a thorough visual inspection after shutdown. Repeat the check run if any repairs are necessary as a result of the run or the inspection.*

*The check run is complete after setting No. 6 unless a new compressor has been installed on the engine. To obtain seal wear-in on the new compressor, continue to the completion of the listed check run settings.*

7. Start engine, accelerate and stabilize at Ground Idle.
8. Accelerate to take off power, stabilize for five minutes then proceed.
9. Reduce to Ground Idle, dwell for two minutes; then shut down.

**3-180A. Propeller Check Run.** Following removal and replacement of the engine or the propeller, purge trapped air from the propeller oil system. Purge the prop oil system and subject the propeller to a run cycle during ground operation prior to the first flight using the following check run:

- a. Perform a normal start.
- b. Advance the power lever to the highest power attainable during ground operation.
- c. Retard the power lever to reverse propeller operation.
- d. Return the power lever to Ground Idle.
- e. Perform a normal shutdown. Check that the propeller moves to Feather.
- f. Repeat the procedure (steps a. through e.) a second time.

**3-181. PREPARATION FOR STORAGE AND SHIPMENT.**

3-182. Engines that have been repaired and check run and will not be installed in an aircraft or engines going to overhaul are to be prepared for storage and/or shipment in accordance with the following paragraphs. Engines placed in storage must be inspected every 12 months.(Refer to Preservation Surveillance, para 3-197.)



**3-183. ENGINE PRESERVATION.**

3-184. Preserve the engine as follows:

- a. Drain the oil from the power and accessories gearbox by removing the bottom drain plug. Clean and replace the plug after the oil has been drained.
- b. Disconnect the oil scavenge lines (two) from the turbine sumps. Remove the oil from these sumps with a suction pump or aspirator. Reconnect lines after oil has been removed.
- c. Preserve the compressor in accordance with Compressor Preservation, para 3-45, if storage will exceed 5 days.
- d. If the engine is to be stored for less than 45 days no further preservation is required.
- e. If the storage period will exceed 45 days, continue with the preservation as follows:
  - (1) Preserve the fuel system in accordance with Fuel System Preservation, para 3-44.
  - (2) Install covers on the compressor inlet and the exhaust collector stacks.
  - (3) Store the container indoors.

**3-185. PREPARATION OF THE ENGINE.**

3-186. Prepare the preserved engine for shipment as follows:

- a. Coat accessory drives which do not have accessories installed on them with engine oil. Brush internal splines with anti-seize compound (Lubriplate 130A, or equivalent) and assemble shipping covers, gaskets, washers and nuts.
- b. Touch up paint film where damaged. Do not expose touch up areas to engine fluids or cleaning solvents for a minimum period of 72 hours after application.
- c. All shipping parts, except accessory drive pad covers and related parts attached to the engine, shall be identified by a light yellow color. The color may be paint or any other acceptable process which is noncorrosive, permanent and not subject to deterioration by engine fluids and solvents.
- d. Letters and numbers of stenciled markings shall be block letters 3/4-in. (19 mm) high minimum.
- e. Tighten aluminum and plastic shipping caps and plugs finger tight.
- f. Tighten threaded parts to standard torques.

**CAUTION**

*Remove all shipping closures prior to engine operation except covers on those accessory drive pads which are not used for attachment of aircraft accessories.*

**3-187. INSTALLATION OF ENGINE IN CONTAINER.**

3-188. Install the engine in the drum-type shipping container (P/N 6870176) as follows:

- a. Depress and hold the relief valve manual release button until the air pressure inside the container is zero.
- b. Remove the drum front head by removing the nut, bolt, and clamping band assembly.
- c. Remove the cloth bag containing bracket mounting hardware.
- d. Remove the two nuts, lockwashers, and bolts retaining the engine suspension frame assembly to the side rail assembly. Slide the frame from the drum. The frame will rest on two yokes.
- e. For a turboprop engine installation the bottom mount shall be set up as follows:
  - (1) The male adapter bracket installed in the bracket support plate and retained by two flat head pins at the rear set of holes. Each pin secured by a hairpin.
  - (2) The female adapter bracket installed on the male adapter bracket and retained by a flat head pin. Pin secured by a hairpin.
  - (3) Turboprop engine mounting bracket (VE-5-1647-100) installed on the bottom mount of the engine. Bracket secured with three bolts and washers. Two long bolts tightened to 85-110 lb in. (9.60-12.43 N-m) and short bolt tightened to 140-165 lb in. (15.82-18.64 N-m). Bolts lockwired in threes.

**NOTE**

*The turboshaft engine mounting bracket is secured to the storage bracket assembly in the drum.*

f. For a turboprop engine installation the side mounts shall be set up as follows:

- (1) The two engine mounting brackets installed on the side mounts of the engine. Each secured with three bolts and washers. Bolts tightened to 85-110 lb in. (9.60-12.43 N-m) and lockwired in threes.
- (2) Pins pulled and the two engine mounting bracket support adapters moved outboard flush with the inside edge of the adapter support bushing.
- g. Coil the thermocouple lead and secure it to the top of the turbine with one-inch masking tape.

**CAUTION**

*Avoid sharp bends when coiling the thermocouple lead.*



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h. Lower the engine onto the engine suspension frame assembly. The bottom engine mounting bracket must engage the female adapter bracket. Stop lowering the engine when the side mounting brackets are aligned with the engine mounting bracket support adapters. Secure each of the two adapters to the mounting brackets with a flat head pin and hairpin. Secure each of the two adapters to the adapter support bushings with a flat head pin and hairpin. Release engine weight onto the frame.

i. Tie the empty cloth bag to the desiccant receptacle for future use.

j. Lift or hoist the engine loaded frame until the side rails align with the side rail assemblies. Slide the frame into the drum.

----- NOTE -----  
*If a hoist was used to lift the engine loaded frame assembly, the lift tool must be removed from the engine top pad before the engine can slide all the way into the drum.*  
-----

k. Secure the side rails to the side rail assemblies with a bolt, lockwasher, and nut on each side. Tighten nuts to 150-180 lb in.

l. Place two 16-unit bags of desiccant into the desiccant receptacle. Replace the humidity indicator element only if necessary.

m. Assemble the closure gasket and the front head on the drum. Secure the head with the clamping band. Use a special scissors-type clinch tool to hold the band so that the retaining bolt and nut can be installed. Tighten nut until the head, gasket, and band are seated firmly. Lead-seal lockwire the bolt to the bushing sleeve.

n. Place one copy of EDS 1311 and applicable engine records in a plastic envelope. Store the envelope in the records receptacle. Lead-seal lockwire the cover to the receptacle.

o. Coat the nut end of the container closure bolt with corrosion preventive compound.

3-189. Install the engine in a rectangular-type shipping container (P/N 6873174) as follows:

a. Depress and hold the relief valve manual release button until air pressure inside the container is zero.

b. Remove the eight nuts and screws securing the cover to the base. Attach a hoist at the lifting hooks and remove the container cover from the base.

c. For a turboprop engine installation the bottom mount shall be set up as follows:

(1) The lower mounting bracket installed in the lower mounting bracket plate with the tube nearer to the

aft side of the channel than it is to the forward side, with the tube up. Bracket attached by two flat head pins, each secured with a hairpin.

(2) Turboprop engine mounting bracket (3-12147-1) installed on the bottom mount of the engine. Bracket secured with three bolts and washers. Two long bolts tightened to 85-110 lb in. and the short bolt tightened to 140-165 lb in. Bolts lockwired in threes.

----- NOTE -----  
*The turboshaft engine mounting bracket (3-10301-1) is secured at the storage position on the channel weldment.*  
-----

d. For turboprop engine installation, the side mounts shall be set up as follows:

(1) The two engine mounting brackets installed on the side mounts of the engine. Each bracket secured with three bolts and washers. Bolts tightened to 85-110 lb in. and lockwired in threes.

(2) Engine mounting bracket adapters installed in the bottom hole of the upper mounting adapter support bracket. Pins pulled and engine mounting bracket adapters moved outboard flush with the inside edge of the upper mounting support bracket.

e. Coil the thermocouple lead and secure it to the top of the turbine with one-inch masking tape.

----- CAUTION -----  
*Avoid sharp bends when coiling the thermocouple lead.*  
-----

f. Lower the engine onto the base assembly. The bottom engine mounting bracket must engage the tube of the lower mounting bracket. Stop lowering the engine when the side mounting brackets are aligned with the engine mounting bracket adapters. Slide the adapters inboard to engage the engine side mounting brackets. Secure each of the two adapters to the mounting brackets with a flat head pin and hairpin. Secure each of the two adapters to the upper mounting adapter support bracket with a flat head pin and hairpin. Release the engine weight onto the base. Remove the lifting hoist.

g. Tie the empty cloth sack to the mounting frame upper tube for future use.

h. Place two 16-unit bags of desiccant into the desiccant receptacle. Replace the humidity indicator element only if necessary.



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i. Position the closure gasket then lower the cover over the engine loaded base. Align cover to base at each end with a locating pin. Be sure the closure gasket is properly seated.

j. Remove the hoist from the cover. Attach the cover to the base with eight screws and nuts (nut end up). Tighten nuts to 150-165 lb in.

k. Lead-seal wire the cover to the base at the two tamper-proof security holes.

l. Remove the records receptacle cover. Place one copy of EDS 1312 and applicable engine records in the receptacle. Install the cover; secure with four screws, flat washers, and rubber washers. Tighten screws to 30-40 lb in. Lead-seal lockwire screws in pairs.

m. Coat the nut end of the container closure bolts with corrosion preventive compound.

3-190. Install the engine in the pressurized-type shipping container (P/N 6870352) as follows:

a. Loosen the nut then swing the service receptacle cover out of the way. Reduce air pressure in the container to zero psig by loosening or removing the air valve or by pressing the manual release button on the relief valve.

b. Remove the 32 screws and nuts at the container splitline. Remove the cover using a hoist.

c. For a turboprop engine installation the bottom mount shall be set up as follows:

(1) The lower mounting bracket installed in the lower mounting bracket plate with the tube nearer to the aft side of the mounting yoke than it is to the forward side, with the tube up. Bracket attached by two flat head pins, each secured with a hairpin.

(2) Turboprop engine mounting bracket (3-12147-1) installed on the bottom mount of the engine. Bracket secured with three bolts and washers. Two short bolts tightened to 85-110 lb in. and long bolt tightened to 140-165 lb in. Bolts lockwired in threes.

----- **NOTE** -----

*The turboshaft engine mounting bracket (3-10301-1) is secured at the storage position on the mounting yoke.*

d. For turboprop engine installation, the side mounts shall be set up as follows:

(1) The two engine mounting brackets installed on the side mounts of the engine. Each bracket secured with three bolts and washers. Bolts tightened to 85-110 lb in. and lockwired in threes.

(2) Engine mounting bracket adapters installed in the bottom hole of the upper mounting adapter support bracket. Pins pulled and engine mounting bracket adapters moved outboard flush with the inside edge of the upper mounting support bracket.

e. Coil the thermocouple lead and secure it to the top of the turbine with one-inch masking tape.

----- **CAUTION** -----

*Avoid sharp bends when coiling the thermocouple lead.*

f. Lower the engine into the shipping container base. Let the bottom engine mounting bracket engage the tube of the bottom container bracket. Stop lowering the engine when the shafts of the two side engine mounting brackets are aligned with their respective retaining tubes.

g. Slide the two side mounting bracket retaining tubes inboard until they engage the mounting brackets on the engine. Secure each with a flat head pin and a cotter pin. Secure the retaining tubes to the upper engine mounting support brackets with a flat head pin and cotter pin at each bracket.

h. Release the complete engine weight into the container. Remove the lifting brackets and/or slings.

i. Tie the cloth sack to the desiccant basket.

j. Place two 16-unit bags of desiccant in the desiccant basket.

k. Position the closure gasket then lower the cover over the engine loaded base.

l. Remove the hoist from the cover. Attach the cover to the base with 32 screws and nuts (nut ends up). Tighten one nut on each side in the center and one at each of the four corners then tighten the remaining nuts. Tighten nuts to 150-165 lb in.

m. Replace or retighten the air valve then pressurize the container to 5.0 ± 0.5 psig at 70°F using clean dry air. Refer to table III-10 for pressure vs temperature relationship applicable to containers.

n. Check the records receptacle, humidity indicator, drain plug, service receptacle gasket, air valve, relief valve, and container splitline closure gasket for air leaks. Use a soap and water solution for the leak check. If leaks are found retorque and/or repair as necessary to stop leaks. Recheck the pressure in accordance with the values in table III-10. Do not overtorque the closure bolts. Tamper proof the shipping container by lead-seal lockwiring the container cover to the base at the holes provided at the two opposite corners.



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----- NOTE -----

*Recheck the container pressure and humidity indicator if the engine has not been shipped within 24 hours of the time the container was pressurized. Also, recheck the container pressure and the humidity indicator immediately before the time of actual shipment. (Refer to Preservation Surveillance, para 3-197.)*

o. Reassemble the service receptacle cover to the service receptacle. Secure with two nuts. Tighten nuts to 15-25 lb in. Tamper proof the cover using lockwire with a lead seal.

TABLE III-10

Shipping Container Air Pressure Chart

Temperature (°F)	Pressure (psig)	Temperature (°F)	Pressure (psig)
+140	7.6	+40	3.9
+130	7.3	+30	3.5
+120	6.9	+20	3.2
+110	6.5	+10	2.8
+100	6.1	0	2.4
+ 90	5.8	-10	2.0
+ 80	5.4	-20	1.7
+ 70	5.0	-30	1.3
+ 60	4.6	-40	0.9
+ 50	4.3		

p. Place one copy of EDS1337 and applicable engine records in a plastic envelope. Store the envelope in the records receptacle. Secure with two nuts. Tighten nuts to 30-45 lb in. Tamper proof the cover using lockwire with a lead seal.

q. Coat the nut ends of the records receptacle studs, the service receptacle bolts, and the closure screws with corrosion preventive compound.

**3-191. REMOVAL OF ENGINE FROM CONTAINER.**

3-192. Remove the engine from the drum-type shipping container (P/N6870176) as follows:

a. Depress and hold the relief valve manual release button until the air pressure inside the container is zero. Remove the drum front head by removing the nut, bolt, and clamping band assembly.

b. Remove the cloth bag containing bracket mounting hardware.

c. Remove the two nuts, lockwashers, and bolts retaining the engine loaded frame assembly to the side rails. Slide the

engine and frame assembly from the drum. The frame will rest on two yokes.

----- CAUTION -----

*Provide adequate support at both ends of the loaded frame to prevent it from falling to the floor as the load is disengaged from the side rails. The frame can be supported by attaching a lift tool and hoist at the engine top mounting pad when the frame is about half way out of the drum.*

d. Adjust the hoist to take the engine weight off of the frame assembly.

e. Separate the two engine mounting bracket support adapters from the adapter support bushings and from the engine mounting brackets by removing the hairpin and flat head pin at each location. Slide the two adapters outboard until they are flush with the inside edge of the adapter support bushings.

f. Hoist the engine from the frame assembly.

g. Remove the three mounting brackets from the engine.

h. Reinstall container parts into their respective locations and place loose hardware in the cloth bag. Tie the bag to the desiccant receptacle for future use.

i. If the container will be exposed to corrosive conditions, coat the nut end of the closure bolt with corrosion preventive compound.

3-193. Remove the engine from a rectangular-type shipping container (P/N6873174) as follows:

a. Depress and hold the relief valve manual release button until the air pressure inside the container is zero.

b. Remove the eight screws and nuts securing the cover to the base. Attach a hoist at the lifting hooks and remove the container cover from the base.

c. Attach a lift bracket and hoist to the engine top mounting pad. Adjust the hoist to take the engine weight off of the container suspension system.

d. Separate the two engine mounting bracket adapters from the side engine mounting brackets and from the upper mounting adapter support brackets by removing a hairpin and flat head pin at each location. Slide the two adapters outboard until they are flush with the inside edge of the support brackets.

e. Hoist the engine out of the container.

f. Remove the engine mounting brackets from the bottom and both sides of the engine.

g. Reinstall container parts into their respective locations and place loose hardware in the cloth sack. Tie the cloth sack to the mounting frame upper tube for future use.

h. If the container will be exposed to corrosive conditions, coat the nut end of the eight closure screws with corrosion preventive compound.



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3-194. Remove the engine from the pressurized-type shipping container (P/N6870352) as follows:

- a. Loosen the nut then swing the service receptacle cover out of the way. Reduce air pressure in the container to zero psig by loosening or removing the air valve or by pressing the manual release button on the relief valve.
- b. Remove the 32 nuts and screws at the splitline. Remove the container cover using a hoist.
- c. Remove the weight from the engine in the container using a hoist at the lifting bracket at the top of the engine.
- d. Remove the cotter pins and flat head pins securing the two retaining tubes at the upper engine mounting support brackets and at the mounting brackets for the engine side mounting pads. Slide the retaining tubes outboard until their inboard ends are flush with the inboard sides of the upper engine mounting support brackets.
- e. Hoist the engine out of the container.
- f. Remove the three mounting brackets from the engine.
- g. Reinstall container parts at their storage locations. Place loose hardware in the cloth bag.
- h. If the container will be subjected to weather or corrosive conditions during storage, coat nut ends of the records receptacle studs, the service receptacle bolts, and the closure screws with corrosive preventive compound.

**3-195. CONTAINER REUSE.**

3-196. The containers are designed to be reusable. Re-use as many of the shipping parts stored within the container as possible.

**3-197. PRESERVATION SURVEILLANCE.**

3-198. The shipping package must undergo humidity indicator element inspection upon receipt of the engine. The inspection shall be repeated every 30 days.

a. If the humidity indicator is light blue, the moisture level in the container has been satisfactory. Make note of the humidity inspection in the Engine Log.

b. If the humidity indicator is light lavender or pink, the moisture level in the container has been unsatisfactory. Return the engine to storage condition as follows:

(1) Remove the engine from the container and inspect for evidence of moisture. Normally the first condition encountered will be galvanic corrosion in areas having dissimilar metals in contact with each other such as steel bolts and fittings contacting the magnesium gearbox.

(2) If corrosion is not found, replace the humidity indicator element and return the engine to storage.

(3) If corrosion is found, clean or replace the corroded parts as necessary. Remove shipping parts and install the engine on a test stand or in an airframe. Start the engine and accelerate to Ground Idle. Operate at this engine power setting or above for a sufficient length of time (approx. five minutes) to accomplish the following: depressure the fuel system, recoat all lubricated interior components, and thoroughly remove moisture from the engine. Upon completion of the engine run, preserve the engine and return it to storage in the normal manner described in this section.

(4) Replace or rejuvenate the desiccant. Replace with No. 88 Absorbant Protective Dehydrating Agent, or equivalent (MIL-D-3464). Desiccant can be rejuvenated by heating in an oven at 250°F (121°C) for 16 hours.

(5) Make note of the inspection and ensuing actions in the Engine Log.



## APPENDIX A

### ENGLISH-TO-METRIC CONVERSIONS

**A-1. INTRODUCTION**

A-2. The conversion tables in this appendix can be used to convert handbook values to equivalent SI metric units (International System of Units).

A-3. The following conversions tables and data are included:

	<i>Page</i>		<i>Page</i>
Conversion Formulae and Procedures	A-2	Torque—Pound Feet to Newton Metres	A-5
Length—Inches to Millimetres	A-3	Power—Horsepower to Kilowatts	A-5
Temperature—°C to °F and °F to °C	A-4	Capacity—Gallons to Litres	A-6
Torque—Pound Inch to Newton Metres	A-5	Capacity—Ounces to Millimetres	A-6
		Pressure—Inches of Mercury to Kilopascals	A-6
		Pressure—Pounds per Square Inch to Kilopascals	A-6
		Force—Ounces or Pounds to Newtons	A-7
		Force—Pounds to Newtons	A-7
		Mass—Ounces or Pounds to Kilograms	A-7
		Mass—Pounds to Kilograms	A-7
		Distance—Miles to Kilometres	A-8
		Length—Microinches to Microns	A-8



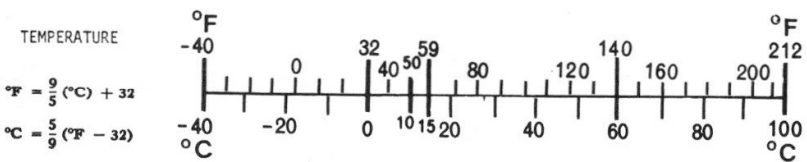
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**ENGLISH TO METRIC CONVERSIONS**

Multiply	by	to get equivalent number of:	Multiply	by	to get equivalent number of:
<b>LENGTH</b>			<b>ACCELERATION</b>		
Inch	25.4	millimetres (mm)	Foot/sec <sup>2</sup>	0.304 8	metre/sec <sup>2</sup> (m/s <sup>2</sup> )
Foot	0.304 8	metres (m)	Inch/sec <sup>2</sup>	0.025 4	metre/sec <sup>2</sup>
Yard	0.914 4	metres			
Mile	1.609	kilometres (km)			
<b>AREA</b>			<b>TORQUE</b>		
Inch <sup>2</sup>	645.2	millimetres <sup>2</sup> (mm <sup>2</sup> )	Pound-inch	0.112 98	newton-metres (N·m)
Foot <sup>2</sup>	6.45	centimetres <sup>2</sup> (cm <sup>2</sup> )	Pound-foot	1.355 8	newton-metres
Foot <sup>2</sup>	0.092 9	metres <sup>2</sup> (m <sup>2</sup> )			
Yard <sup>2</sup>	0.836 1	metres <sup>2</sup>			
<b>VOLUME</b>			<b>POWER</b>		
Inch <sup>3</sup>	16 387.	mm <sup>3</sup>	Horsepower	0.746	kilowatts (kW)
	16.387	cm <sup>3</sup>			
Quart	0.016 4	litres (l)			
Gallon	0.946 4	litres			
Yard <sup>3</sup>	3.785 4	litres			
	0.764 6	metres <sup>3</sup> (m <sup>3</sup> )			
<b>MASS</b>			<b>PRESSURE OR STRESS</b>		
Pound	0.453 6	kilograms (kg)	Inches of mercury	3.377	kilopascals (kPa)
Ton	907.18	kilograms	Inches of water	0.249 1	kilopascals
Ton	0.907	tonne (t)	Pounds/sq. in.	6.895	kilopascals
<b>FORCE</b>			<b>ENERGY OR WORK</b>		
Kilogram	9.807	newtons (N)	BTU	1 055.	joules (J)
Ounce	0.278 0	newtons	Foot-pound	1.355 8	joules
Pound	4.448	newtons	Kilowatt-hour	3.6x10 <sup>6</sup> or 3 600 000	joules (J = one W·s)
<b>VELOCITY</b>			<b>LIGHT</b>		
Miles/hour	1.609 3	kilometres/hr (km/h)	Footcandle	10.764	lumens/metre <sup>2</sup> (lm/m <sup>2</sup> )
<b>FUEL PERFORMANCE</b>			<b>FUEL PERFORMANCE</b>		
Miles/gal	0.425 1	kilometres/litre (km/l)			
Gal/mile	2.352 7	litres/kilometre (l/km)			

Degree (angle) 0.017 5 radians (rad)  
Ounce (mass)-inch 720.077 8 milligram-metre (mg·m)  
(balancing)



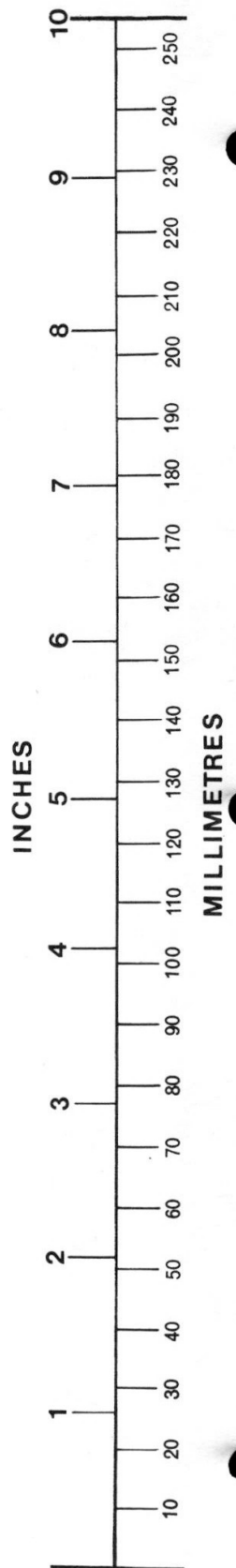
USE CONVERSION TABLES LIKE THIS:

13 hp = ? kW Read across the 10 line to the 3 column. Read 9.7 kW

**POWER—HORSEPOWER TO KILOWATTS**

(1 hp = 0.745 699 9 kW)

hp	0	1	2	3	4	5	6	7	8	9
	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
0		0.75	1.49	2.24	2.98	3.73	4.47	5.22	5.97	
10	7.5	8.2	8.9	9.7	10.4	11.2	11.9	12.7		
20	14.9	15.7	16.4	17.2	17.9	18.6	19.4	20.1		
30	22.4	23.1	23.9	24.6	25.4	26.1	26.9	27.6		
40	29.8	30.6	31.4	32.2	33.0	33.8	34.6	35.4		





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**LENGTH — INCHES TO MILLIMETRES**

(1 in. = 25.4 mm)

Decimal (in.)	Fraction (in.)	(mm)	Decimal (in.)	Fraction (in.)	(mm)	Decimal (in.)	Fraction (in.)	(mm)
.015625	1/64	.39688	.34375	11/32	8.73125	.6875	11/16	17.46250
.03125	1/32	.79375	.359375	23/64	9.12812	.703125	45/64	17.85937
.046875	3/64	1.19062	.375	3/8	9.52500	.71875	23/32	18.25625
.0625	1/16	1.58750	.390625	25/64	9.92187	.734375	47/64	18.65312
.078125	5/64	1.98437	.40625	13/32	10.31875	.750	3/4	19.05000
.09375	3/32	2.38125	.421875	27/64	10.71562	.765625	49/64	19.44687
.109375	7/64	2.77812	.4375	7/16	11.11250	.78125	25/32	19.84375
.125	1/8	3.17500	.453125	29/64	11.50937	.796875	51/64	20.24062
.140625	9/64	3.57187	.46875	15/32	11.90625	.8125	13/16	20.63750
.15625	5/32	3.96875	.484375	31/64	12.30312	.828125	53/64	21.03437
.171875	11/64	4.36562	.500	1/2	12.70000	.84375	27/32	21.43125
.1875	3/16	4.76250	.515625	33/64	13.09687	.859375	55/64	21.82812
.203125	13/64	5.15937	.53125	17/32	13.49375	.875	7/8	22.22500
.21875	7/32	5.55625	.546875	35/64	13.89062	.890625	57/64	22.62187
.234375	15/64	5.95312	.5625	9/16	14.28750	.90625	29/32	23.01875
.250	1/4	6.35000	.578125	37/64	14.68437	.921875	59/64	23.41562
.265625	17/64	6.74687	.59375	19/32	15.08125	.9375	15/16	23.81250
.28125	9/32	7.14375	.609375	39/64	15.47812	.953125	61/64	24.20937
.296875	19/64	7.54062	.625	5/8	15.87500	.96875	31/32	24.60625
.3125	5/16	7.93750	.640625	41/64	16.27187	.984375	63/64	25.00312
.328125	21/64	8.33437	.65625	21/32	16.66875	1.00	1	25.40000
			.671875	43/64	17.06562			

in.	0	.0001	.0002	.0003	.0004	.0005	.0006	.0007	.0008	.0009
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
.0000	-	.00254	.00508	.00762	.01016	.01270	.01524	.01778	.02032	.02286
.0010	.02540	.02794	.03048	.03302	.03556	.03810	.04064	.04318	.04572	.04826
.0020	.05080	.05334	.05588	.05842	.06096	.06350	.06604	.06858	.07112	.07366
.0030	.07620	.07874	.08128	.08382	.08636	.08890	.09144	.09398	.09652	.09906
.0040	.10160	.10414	.10668	.10922	.11176	.11430	.11684	.11938	.12192	.12446
.0050	.12700	.12954	.13208	.13462	.13716	.13970	.14224	.14478	.14732	.14986
.0060	.15240	.15494	.15748	.16002	.16256	.16510	.16764	.17018	.17272	.17526
.0070	.17780	.18034	.18288	.18542	.18796	.19050	.19304	.19558	.19812	.20066
.0080	.20320	.20574	.20828	.21082	.21336	.21590	.21844	.22098	.22352	.22606
.0090	.22860	.23114	.23368	.23622	.23876	.24130	.24384	.24638	.24892	.25146

in.	0	.0010	.0020	.0030	.0040	.0050	.0060	.0070	.0080	.0090
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
.0100	.2540	.2794	.3048	.3302	.3556	.3810	.4064	.4318	.4572	.4826
.0200	.5080	.5334	.5588	.5842	.6096	.6350	.6604	.6858	.7112	.7366
.0300	.7620	.7874	.8128	.8382	.8636	.8890	.9144	.9398	.9652	.9906
.0400	1.0160	1.0414	1.0668	1.0922	1.1176	1.1430	1.1684	1.1938	1.2192	1.2446
.0500	1.2700	1.2954	1.3208	1.3462	1.3716	1.3970	1.4224	1.4478	1.4732	1.4986
.0600	1.5240	1.5494	1.5748	1.6002	1.6256	1.6510	1.6764	1.7018	1.7272	1.7526
.0700	1.7780	1.8034	1.8288	1.8542	1.8796	1.9050	1.9304	1.9558	1.9812	2.0066
.0800	2.0320	2.0574	2.0828	2.1082	2.1336	2.1590	2.1844	2.2098	2.2352	2.2606
.0900	2.2860	2.3114	2.3368	2.3622	2.3876	2.4130	2.4384	2.4638	2.4892	2.5146

in.	0	.0100	.0200	.0300	.0400	.0500	.0600	.0700	.0800	.0900
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
.1000	2.540	2.794	3.048	3.302	3.556	3.810	4.064	4.318	4.572	4.826
.2000	5.080	5.334	5.588	5.842	6.096	6.350	6.604	6.858	7.112	7.366
.3000	7.620	7.874	8.128	8.382	8.636	8.890	9.144	9.398	9.652	9.906
.4000	10.160	10.414	10.668	10.922	11.176	11.430	11.684	11.938	12.192	12.446
.5000	12.700	12.954	13.208	13.462	13.716	13.970	14.224	14.478	14.732	14.986
.6000	15.240	15.494	15.748	16.002	16.256	16.510	16.764	17.018	17.272	17.526
.7000	17.780	18.034	18.288	18.542	18.796	19.050	19.304	19.558	19.812	20.066
.8000	20.320	20.574	20.828	21.082	21.336	21.590	21.844	22.098	22.352	22.606
.9000	22.860	23.114	23.368	23.622	23.876	24.130	24.384	24.638	24.892	25.146

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-459.4 to -220		-210 to 0		1 to 25		26 to 50		51 to 75		76 to 100		101 to 340		341 to 490		491 to 750	
C.	C. <sup>o</sup> F.	C.	C. <sup>o</sup> F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.	C. <sup>o</sup> F.	F.
-220	-364	-140	-220	-364	-140	-220	-364	-140	-220	-364	-140	-220	-364	-140	-220	-364	-140
-190	-310	-184	-300	-179	-290	-173	-280	-169	-273	-166	-270	-163	-267	-160	-263	-157	-260
-157	-250	-151	-240	-146	-230	-141	-220	-136	-210	-131	-200	-126	-190	-121	-180	-116	-170
-119	-190	-113	-180	-108	-170	-103	-160	-98	-150	-93	-140	-88	-130	-83	-120	-78	-110
-78	-110	-73	-100	-68	-90	-63	-80	-58	-70	-53	-60	-48	-50	-43	-50	-38	-40
-34	-50	-29	-40	-24	-30	-19	-20	-14	-10	-9	-10	-6	-5	-4	-4	-3	-2
10	60	15	50	20	40	25	30	30	40	35	35	35	35	35	35	35	35
51	60	56	45	51	40	57	30	64	15	71	15	77	15	83	15	89	15
62	50	58	40	65	30	71	15	77	15	83	15	89	15	95	15	101	15
73	40	79	30	85	20	91	10	97	5	103	5	109	5	115	5	121	5
84	30	90	20	96	10	102	5	108	0	114	0	120	0	126	0	132	0
95	20	101	10	107	0	113	-5	119	-10	125	-10	131	-10	137	-10	143	-10
106	10	112	0	118	-5	124	-10	130	-15	136	-15	142	-15	148	-15	154	-15
117	0	123	-5	129	-10	135	-15	141	-20	147	-20	153	-20	159	-20	165	-20
128	-5	134	-10	140	-15	146	-20	152	-25	158	-25	164	-25	170	-25	176	-25
139	-10	145	-15	151	-20	157	-25	163	-30	169	-30	175	-30	181	-30	187	-30
150	-15	156	-20	162	-25	168	-30	174	-35	180	-35	186	-35	192	-35	198	-35
161	-20	167	-25	173	-30	179	-35	185	-40	191	-40	197	-40	203	-40	209	-40
172	-25	178	-30	184	-35	190	-40	196	-45	202	-45	208	-45	214	-45	220	-45
183	-30	189	-35	195	-40	201	-45	207	-50	213	-50	219	-50	225	-50	231	-50
194	-35	200	-40	206	-45	212	-50	218	-55	224	-55	230	-55	236	-55	242	-55
205	-40	211	-45	217	-50	223	-55	229	-60	235	-60	241	-60	247	-60	253	-60
216	-45	222	-50	228	-55	234	-60	240	-65	246	-65	252	-65	258	-65	264	-65
227	-50	233	-55	239	-60	245	-65	251	-70	257	-70	263	-70	269	-70	275	-70
238	-55	244	-60	250	-65	256	-70	262	-75	268	-75	274	-75	280	-75	286	-75
249	-60	255	-65	261	-70	267	-75	273	-80	279	-80	285	-80	291	-80	297	-80
260	-65	266	-70	272	-75	278	-80	284	-85	290	-85	296	-85	302	-85	308	-85
271	-70	277	-75	283	-80	289	-85	295	-90	301	-90	307	-90	313	-90	319	-90
282	-75	288	-80	294	-85	300	-90	306	-95	312	-95	318	-95	324	-95	330	-95
293	-80	299	-85	305	-90	311	-95	317	-100	323	-100	329	-100	335	-100	341	-100
304	-85	310	-90	316	-95	322	-100	328	-105	334	-105	340	-105	346	-105	352	-105
315	-90	321	-95	327	-100	333	-105	339	-110	345	-110	351	-110	357	-110	363	-110
326	-95	332	-100	338	-105	344	-110	350	-115	356	-115	362	-115	368	-115	374	-115
337	-100	343	-105	349	-110	355	-115	361	-120	367	-120	373	-120	379	-120	385	-120
348	-105	354	-110	360	-115	366	-120	372	-125	378	-125	384	-125	390	-125	396	-125
359	-110	365	-115	371	-120	377	-125	383	-130	389	-130	395	-130	401	-130	407	-130
370	-115	376	-120	382	-125	388	-130	394	-135	400	-135	406	-135	412	-135	418	-135
381	-120	387	-125	393	-130	399	-135	405	-140	411	-140	417	-140	423	-140	429	-140
392	-125	398	-130	404	-135	410	-140	416	-145	422	-145	428	-145	434	-145	440	-145
403	-130	409	-135	415	-140	421	-145	427	-150	433	-150	439	-150	445	-150	451	-150
414	-135	420	-140	426	-145	432	-150	438	-155	444	-155	450	-155	456	-155	462	-155
425	-140	431	-145	437	-150	443	-155	449	-160	455	-160	461	-160	467	-160	473	-160
436	-145	442	-150	448	-155	454	-160	460	-165	466	-165	472	-165	478	-165	484	-165
447	-150	453	-155	459	-160	465	-165	471	-170	477	-170	483	-170	489	-170	495	-170
458	-155	464	-160	470	-165	476	-170	482	-175	488	-175	494	-175	500	-175	506	-175
469	-160	475	-165	481	-170	487	-175	493	-180	499	-180	505	-180	511	-180	517	-180
480	-165	486	-170	492	-175	498	-180	504	-185	510	-185	516	-185	522	-185	528	-185
491	-170	497	-175	503	-180	509	-185	515	-190	521	-190	527	-190	533	-190	539	-190
502	-175	508	-180	514	-185	520	-190	526	-195	532	-195	538	-195	544	-195	550	-195
513	-180	519	-185	525	-190	531	-195	537	-200	543	-200	549	-200	555	-200	561	-200
524	-185	530	-190	536	-195	542	-200	548	-205	554	-205	560	-205	566	-205	572	-205
535	-190	541	-195	547	-200	553	-205	559	-210	565	-210	571	-210	577	-210	583	-210
546	-195	552	-200	558	-205	564	-210	570	-215	576	-215	582	-215	588	-215	594	-215
557	-200	563	-205	569	-210	575	-215	581	-220	587	-220	593	-220	599	-220	605	-220
568	-205	574	-210	580	-215	586	-220	592	-225	598	-225	604	-225	610	-225	616	-225
579	-210	585	-215	591	-220	597	-225	603	-230	609	-230	615	-230	621	-230	627	-230
590	-215	596	-220	602	-225	608	-230	614	-235	620	-235	626	-235	632	-235	638	-235
601	-220	607	-225	613	-230	619	-235	625	-240	631	-240	637	-240	643	-240	649	-240
612	-225	618	-230	624	-235	630	-240	636	-245	642	-245	648	-245	654	-245	660	-245
623	-230	629	-235	635	-240	641	-245	647	-250	653	-250	659	-250	665	-250	671	-250
634	-235	640	-240	646	-245	652	-250	658	-255	664	-255	670	-255	676	-255	682	-255
645	-240	651	-245	657	-250	663	-255	669	-260	675	-260	681	-260	687	-260	693	-260
656	-245	662	-250	668	-255	674	-260	680	-265	686	-265	692	-265	698	-265	704	-265
667	-250	673	-255	679	-260	685	-265	691	-270	697	-270	703	-270	709	-270	715	-270
678	-255	684	-260	690	-265	696	-270	702	-275	708	-275	714	-275	720	-275	726	-275
689	-260	695	-265	701	-270	707	-275	713	-280	719	-280	725	-280	731	-280	737	-280
700	-265	706	-270	712	-275	718	-280	724	-285	730	-285	736	-285	742	-285	748	-285
711	-270	717	-275	723	-280	729	-285	735	-290	741	-290	747	-290	753	-290	759	-290
722	-275	728	-280	734	-285	740	-290	746	-295	752	-295	758	-295	764	-295	770	-295
733	-280	739	-285	745	-290	751	-295	757	-300	763	-300	769	-300	775	-300	781	-300
744	-285	750	-290	756	-295	762	-300	768	-305	774	-305	780	-305	786	-305	792	-305
755	-290	761	-295	767	-300	773	-305	779	-310	785	-310	791	-310	797	-310	803	-310
766	-295	772	-300	778	-305	784	-310	790	-315	796	-315	8					

hp	10	20	30	40	50	60	70	80	90	100
lb-ft	12.2	10.8	9.5	8.1	6.8	5.4	4.1	2.7	1.4	0.7
N-m	1.7	1.5	1.3	1.1	0.9	0.7	0.5	0.4	0.2	0.1
lb-ft	100	200	300	400	500	600	700	800	900	1000
N-m	136	271	407	542	678	813	949	1085	1220	1356
lb-ft	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
N-m	1356	2712	4067	5423	6779	8135	9491	10847	12202	13558

(1 lb-ft = 1.355818 N-m)  
**TORQUE—POUND FEET TO NEWTON METRES**

hp	10	20	30	40	50	60	70	80	90	100
lb-in.	1.02	0.90	0.79	0.68	0.56	0.45	0.34	0.23	0.11	0.01
N-m	1.15	1.02	0.90	0.78	0.66	0.54	0.42	0.30	0.18	0.07
lb-in.	100	200	300	400	500	600	700	800	900	1000
N-m	12.2	24.4	36.6	48.8	61.0	73.2	85.4	97.6	109.8	122.0
lb-in.	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
N-m	122.0	244.0	366.0	488.0	610.0	732.0	854.0	976.0	1098.0	1220.0

(1 lb-in. = 0.1129848 N-m)  
**TORQUE—POUND INCH TO NEWTON METRES**

Multiply hp value by 100

hp	10	20	30	40	50	60	70	80	90	100
(100) <sup>3</sup> KW	224	231	239	246	254	261	268	276	283	291
hp	3	4	4	5	5	6	6	7	7	8
lb-ft	224	231	239	246	254	261	268	276	283	291
N-m	300	300	300	300	300	300	300	300	300	300
lb-ft	100	200	300	400	500	600	700	800	900	1000
N-m	136	271	407	542	678	813	949	1085	1220	1356
lb-ft	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
N-m	1356	2712	4067	5423	6779	8135	9491	10847	12202	13558

(1 hp = 0.7456999 kW)  
**POWER—HORSEPOWER TO KILOWATTS**

hp	10	20	30	40	50	60	70	80	90	100
kw	7.5	14.9	22.4	29.8	37.3	44.7	52.2	59.7	67.2	74.7
hp	0	1	2	3	4	5	6	7	8	9
kw	0.75	1.49	2.24	2.98	3.73	4.47	5.22	5.97	6.72	7.47
kw	10	20	30	40	50	60	70	80	90	100
kw	100	200	300	400	500	600	700	800	900	1000



17 = 1000 mℓ = 33.81 oz

oz	0	1	2	3	4	5	6	7	8	9
mℓ	0	1	2	3	4	5	6	7	8	9
mℓ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
mℓ	1	2	3	4	5	6	7	8	9	
mℓ	10	20	30	40	50	60	70	80	90	100
mℓ	100	110	120	130	140	150	160	170	180	190
mℓ	200	210	220	230	240	250	260	270	280	290
mℓ	300	310	320	330	340	350	360	370	380	390
mℓ	400	410	420	430	440	450	460	470	480	490
mℓ	500	510	520	530	540	550	560	570	580	590
mℓ	600	610	620	630	640	650	660	670	680	690
mℓ	700	710	720	730	740	750	760	770	780	790
mℓ	800	810	820	830	840	850	860	870	880	890
mℓ	900	910	920	930	940	950	960	970	980	990
mℓ	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090

308145

psi	0	1	2	3	4	5	6	7	8	9
kPa	0	1	2	3	4	5	6	7	8	9
kPa	10	20	30	40	50	60	70	80	90	100
kPa	100	110	120	130	140	150	160	170	180	190
kPa	200	210	220	230	240	250	260	270	280	290
kPa	300	310	320	330	340	350	360	370	380	390
kPa	400	410	420	430	440	450	460	470	480	490
kPa	500	510	520	530	540	550	560	570	580	590
kPa	600	610	620	630	640	650	660	670	680	690
kPa	700	710	720	730	740	750	760	770	780	790
kPa	800	810	820	830	840	850	860	870	880	890
kPa	900	910	920	930	940	950	960	970	980	990
kPa	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090

PRESSURE—POUNDS PER SQUARE INCH TO KILOPASCALS  
(1 psi = 6.894 757 kPa)

CAPACITY—FLUID OUNCES TO MILLILITRES  
(1 oz. U.S. fluid = 29.573 53 ml)

1/4 gal = 0.946ℓ    1/2 gal = 1.893ℓ    3/4 gal = 2.839ℓ    @ 60°F (15.56°C)

gal	0	1	2	3	4	5	6	7	8	9
ℓ	0	1	2	3	4	5	6	7	8	9
ℓ	10	20	30	40	50	60	70	80	90	100
ℓ	100	110	120	130	140	150	160	170	180	190
ℓ	200	210	220	230	240	250	260	270	280	290
ℓ	300	310	320	330	340	350	360	370	380	390
ℓ	400	410	420	430	440	450	460	470	480	490
ℓ	500	510	520	530	540	550	560	570	580	590
ℓ	600	610	620	630	640	650	660	670	680	690
ℓ	700	710	720	730	740	750	760	770	780	790
ℓ	800	810	820	830	840	850	860	870	880	890
ℓ	900	910	920	930	940	950	960	970	980	990
ℓ	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090

in. Hg	0	1	2	3	4	5	6	7	8	9
kPa	0	1	2	3	4	5	6	7	8	9
kPa	10	20	30	40	50	60	70	80	90	100
kPa	100	110	120	130	140	150	160	170	180	190
kPa	200	210	220	230	240	250	260	270	280	290
kPa	300	310	320	330	340	350	360	370	380	390
kPa	400	410	420	430	440	450	460	470	480	490
kPa	500	510	520	530	540	550	560	570	580	590
kPa	600	610	620	630	640	650	660	670	680	690
kPa	700	710	720	730	740	750	760	770	780	790
kPa	800	810	820	830	840	850	860	870	880	890
kPa	900	910	920	930	940	950	960	970	980	990
kPa	1000	1010	1020	1030	1040	1050	1060	1070	1080	1090

PRESSURE—INCHES OF MERCURY TO KILOPASCALS  
(1 in. Hg = 3.376 85 kPa)

CAPACITY—GALLONS TO LITRES  
(1 gal U.S. liquid = 3.785 412 ℓ)

250 - B17 Operation and Maintenance



Division of General Motors Corporation

**FORCE—POUNDS TO NEWTONS**

(1 lb = 4.448 222 N) (1 oz = 0.278 0139 N, 1 lb = 4.448 222 N)

oz	lb	oz	lb	oz	lb	oz	lb	oz	lb
9	0	485	100	485	100	485	100	485	100
8	0	480	100	480	100	480	100	480	100
7	0	475	100	475	100	475	100	475	100
6	0	470	100	470	100	470	100	470	100
5	0	465	100	465	100	465	100	465	100
4	0	460	100	460	100	460	100	460	100
3	0	455	100	455	100	455	100	455	100
2	0	450	100	450	100	450	100	450	100
1	0	445	100	445	100	445	100	445	100
0	0	440	100	440	100	440	100	440	100
0	10	435	100	435	100	435	100	435	100
0	20	430	100	430	100	430	100	430	100
0	30	425	100	425	100	425	100	425	100
0	40	420	100	420	100	420	100	420	100
0	50	415	100	415	100	415	100	415	100
0	60	410	100	410	100	410	100	410	100
0	70	405	100	405	100	405	100	405	100
0	80	400	100	400	100	400	100	400	100
0	90	395	100	395	100	395	100	395	100
0	100	390	100	390	100	390	100	390	100
1	0	385	100	385	100	385	100	385	100
1	10	380	100	380	100	380	100	380	100
1	20	375	100	375	100	375	100	375	100
1	30	370	100	370	100	370	100	370	100
1	40	365	100	365	100	365	100	365	100
1	50	360	100	360	100	360	100	360	100
1	60	355	100	355	100	355	100	355	100
1	70	350	100	350	100	350	100	350	100
1	80	345	100	345	100	345	100	345	100
1	90	340	100	340	100	340	100	340	100
2	0	335	100	335	100	335	100	335	100
2	10	330	100	330	100	330	100	330	100
2	20	325	100	325	100	325	100	325	100
2	30	320	100	320	100	320	100	320	100
2	40	315	100	315	100	315	100	315	100
2	50	310	100	310	100	310	100	310	100
2	60	305	100	305	100	305	100	305	100
2	70	300	100	300	100	300	100	300	100
2	80	295	100	295	100	295	100	295	100
2	90	290	100	290	100	290	100	290	100
3	0	285	100	285	100	285	100	285	100
3	10	280	100	280	100	280	100	280	100
3	20	275	100	275	100	275	100	275	100
3	30	270	100	270	100	270	100	270	100
3	40	265	100	265	100	265	100	265	100
3	50	260	100	260	100	260	100	260	100
3	60	255	100	255	100	255	100	255	100
3	70	250	100	250	100	250	100	250	100
3	80	245	100	245	100	245	100	245	100
3	90	240	100	240	100	240	100	240	100
4	0	235	100	235	100	235	100	235	100
4	10	230	100	230	100	230	100	230	100
4	20	225	100	225	100	225	100	225	100
4	30	220	100	220	100	220	100	220	100
4	40	215	100	215	100	215	100	215	100
4	50	210	100	210	100	210	100	210	100
4	60	205	100	205	100	205	100	205	100
4	70	200	100	200	100	200	100	200	100
4	80	195	100	195	100	195	100	195	100
4	90	190	100	190	100	190	100	190	100
5	0	185	100	185	100	185	100	185	100
5	10	180	100	180	100	180	100	180	100
5	20	175	100	175	100	175	100	175	100
5	30	170	100	170	100	170	100	170	100
5	40	165	100	165	100	165	100	165	100
5	50	160	100	160	100	160	100	160	100
5	60	155	100	155	100	155	100	155	100
5	70	150	100	150	100	150	100	150	100
5	80	145	100	145	100	145	100	145	100
5	90	140	100	140	100	140	100	140	100
6	0	135	100	135	100	135	100	135	100
6	10	130	100	130	100	130	100	130	100
6	20	125	100	125	100	125	100	125	100
6	30	120	100	120	100	120	100	120	100
6	40	115	100	115	100	115	100	115	100
6	50	110	100	110	100	110	100	110	100
6	60	105	100	105	100	105	100	105	100
6	70	100	100	100	100	100	100	100	100
6	80	95	100	95	100	95	100	95	100
6	90	90	100	90	100	90	100	90	100
7	0	85	100	85	100	85	100	85	100
7	10	80	100	80	100	80	100	80	100
7	20	75	100	75	100	75	100	75	100
7	30	70	100	70	100	70	100	70	100
7	40	65	100	65	100	65	100	65	100
7	50	60	100	60	100	60	100	60	100
7	60	55	100	55	100	55	100	55	100
7	70	50	100	50	100	50	100	50	100
7	80	45	100	45	100	45	100	45	100
7	90	40	100	40	100	40	100	40	100
8	0	35	100	35	100	35	100	35	100
8	10	30	100	30	100	30	100	30	100
8	20	25	100	25	100	25	100	25	100
8	30	20	100	20	100	20	100	20	100
8	40	15	100	15	100	15	100	15	100
8	50	10	100	10	100	10	100	10	100
8	60	5	100	5	100	5	100	5	100
8	70	0	100	0	100	0	100	0	100
8	80	0	100	0	100	0	100	0	100
8	90	0	100	0	100	0	100	0	100

**MASS—OUNCES OR POUNDS TO KILOGRAMS**

(1 oz = 0.028 349 52 kg) (1 lb = 0.453 592 4 kg)

oz	lb	oz	lb	oz	lb	oz	lb	oz	lb
9	0	0.259	100	0.259	100	0.259	100	0.259	100
8	0	0.227	100	0.227	100	0.227	100	0.227	100
7	0	0.198	100	0.198	100	0.198	100	0.198	100
6	0	0.170	100	0.170	100	0.170	100	0.170	100
5	0	0.142	100	0.142	100	0.142	100	0.142	100
4	0	0.113	100	0.113	100	0.113	100	0.113	100
3	0	0.085	100	0.085	100	0.085	100	0.085	100
2	0	0.057	100	0.057	100	0.057	100	0.057	100
1	0	0.028	100	0.028	100	0.028	100	0.028	100
0	10	0.283	100	0.283	100	0.283	100	0.283	100
0	20	0.45	100	0.45	100	0.45	100	0.45	100
0	30	0.68	100	0.68	100	0.68	100	0.68	100
0	40	0.91	100	0.91	100	0.91	100	0.91	100
0	50	1.14	100	1.14	100	1.14	100	1.14	100
0	60	1.37	100	1.37	100	1.37	100	1.37	100
0	70	1.60	100	1.60	100	1.60	100	1.60	100
0	80	1.83	100	1.83	100	1.83	100	1.83	100
0	90	2.06	100	2.06	100	2.06	100	2.06	100
1	0	2.29	100	2.29	100	2.29	100	2.29	100
1	10	2.52	100	2.52	100	2.52	100	2.52	100
1	20	2.75	100	2.75	100	2.75	100	2.75	100
1	30	2.98	100	2.98	100	2.98	100	2.98	100
1	40	3.21	100	3.21	100	3.21	100	3.21	100
1	50	3.44	100	3.44	100	3.44	100	3.44	100
1	60	3.67	100	3.67	100	3.67	100	3.67	100
1	70	3.90	100	3.90	100	3.90	100	3.90	100
1	80	4.13	100	4.13	100	4.13	100	4.13	100
1	90	4.36	100	4.36	100	4.36	100	4.36	100
2	0	4.59	100	4.59	100	4.59	100	4.59	100
2	10	4.82	100	4.82	100	4.82	100	4.82	100
2	20	5.05	100	5.05	100	5.05	100	5.05	100
2	30	5.28	100	5.28	100	5.28	100	5.28	100
2	40	5.51	100	5.51	100	5.51	100	5.51	100
2	50	5.74	100	5.74	100	5.74	100	5.74	100
2	60	5.97	100	5.97	100	5.97	100	5.97	100
2	70	6.20	100	6.20	100	6.20	100	6.20	100
2	80	6.43	100	6.43	100	6.43	100	6.43	100
2	90	6.66	100	6.66	100	6.66	100	6.66	100
3	0	6.89	100	6.89	100	6.89	100	6.89	100
3	10	7.12	100	7.12	100	7.12	100	7.12	100
3	20	7.35	100	7.35	100	7.35	100	7.35	100
3	30	7.58	100	7.58	100	7.58	100	7.58	100
3									



**Detroit Diesel Allison**  
Division of General Motors Corporation

250 - B17 Operation and Maintenance

**DISTANCE—MILES TO KILOMETRES**

(1 mi = 1.609 344 km)

mi	0	1	2	3	4	5	6	7	8	9
	km	km	km	km	km	km	km	km	km	km
0		1.6	3.2	4.8	6.4	8.0	9.7	11.3	12.9	14.5
10	16.1	17.7	19.3	20.9	22.5	24.0	25.7	27.3	29.0	30.6
20	32.2	33.8	35.4	37.0	38.6	40.2	41.8	43.5	45.1	46.7
30	48.3	49.9	51.5	53.1	54.7	56.3	57.9	59.5	61.2	62.8
40	64.4	66.0	67.6	69.2	70.8	72.4	74.0	75.6	77.2	78.9
50	80.5	82.1	83.7	85.3	86.9	88.5	90.1	91.7	93.3	95.0
60	96.6	98.2	99.8	101.4	103.0	104.6	106.2	107.8	109.4	111.0
70	112.7	114.3	115.9	117.5	119.1	120.7	122.3	123.9	125.5	127.1
80	128.7	130.4	132.0	133.6	135.2	136.8	138.4	140.0	141.6	143.2
90	144.8	146.5	148.1	149.7	151.3	152.9	154.5	156.1	157.7	159.3
mi		100	200	300	400	500	600	700	800	900
km		161	322	483	644	805	966	1 127	1 287	1 448
mi		1000	2000	3000	4000	5000	6000	7000	8000	9000
km		1 609	3 219	4 828	6 437	8 047	9 656	11 265	12 875	14 484
mi		10 000	20 000	30 000	40 000	50 000	60 000	70 000	80 000	90 000
km		16 093	32 187	48 280	64 374	80 467	96 561	112 654	128 748	144 841
mi		100 000	200 000	300 000	400 000	500 000	600 000	700 000	800 000	900 000
km		160 934	321 869	482 803	643 738	804 672	965 606	1 126 541	1 287 475	1 448 410

1/4 mi = 0.402 km    1/2 mi = 0.805 km    3/4 mi = 1.207 km

**LENGTH—MICROINCHES ( $\mu$ in.) TO MICRONS ( $\mu$ m)**

(1  $\mu$  in. = 0.0254  $\mu$ m)

in.	0	1	2	3	4	5	6	7	8	9
	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m	$\mu$ m
0		0.0254	0.051	0.076	0.102	0.127	0.152	0.178	0.203	0.229
10	0.254	0.279	0.305	0.330	0.356	0.381	0.406	0.432	0.458	0.483
20	0.508	0.533	0.559	0.584	0.610	0.635	0.660	0.686	0.711	0.737
30	0.762	0.787	0.813	0.838	0.864	0.889	0.914	0.940	0.965	0.991
40	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.19	1.22	1.24
50	1.27	1.30	1.32	1.35	1.37	1.40	1.42	1.45	1.47	1.50
60	1.52	1.55	1.57	1.60	1.63	1.65	1.68	1.70	1.73	1.75
70	1.78	1.80	1.83	1.85	1.88	1.91	1.93	1.96	1.98	2.01
80	2.03	2.06	2.08	2.11	2.13	2.16	2.18	2.21	2.24	2.26
90	2.29	2.31	2.34	2.36	2.39	2.41	2.44	2.46	2.49	2.51
100	2.54	2.57	2.59	2.62	2.64	2.67	2.69	2.72	2.74	2.77
110	2.79	2.82	2.84	2.87	2.90	2.92	2.95	2.97	3.00	3.02
120	3.05	3.07	3.10	3.12	3.15	3.18	3.20	3.23	3.25	3.28

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