6 SYSTEMS

POWER PLANT

DESCRIPTION

The powerplant in the Model 212 helicopter is a twin-pac installation designed by United Aircraft of Canada Limited (UACL) and designated as the PT6T-3 Turboshaft engine.

The PT6T-3 engine consists of two accessory gearboxes, two identical free-turbine turboshaft power sections, and a single combining gearbox.

AIR MANAGEMENT SYSTEM

The air management system is a dual system of ducts and valves to provide inlet air to each power section, and through an ejector, carries away exhaust gases. Control of the airflow to the ejector is provided by a two position control valve, downstream of the engine inlet duct. During normal operation, the control valve is open and a portion of the air entering the inlet duct is bypassed to the ejector to carry away most foreign particles.

POWER SECTION AIRFLOW

Inlet air from the air management system enters each power section through a circular plenum chamber formed by the compressor inlet case, and is directed to the compressor.

The compressor consists of three axial stages and a single centrifugal stage of compression, acting as a single integral unit. Compressed air from the centrifugal compressor passes through diffuser pipes and straightening vanes to the combustion chamber.

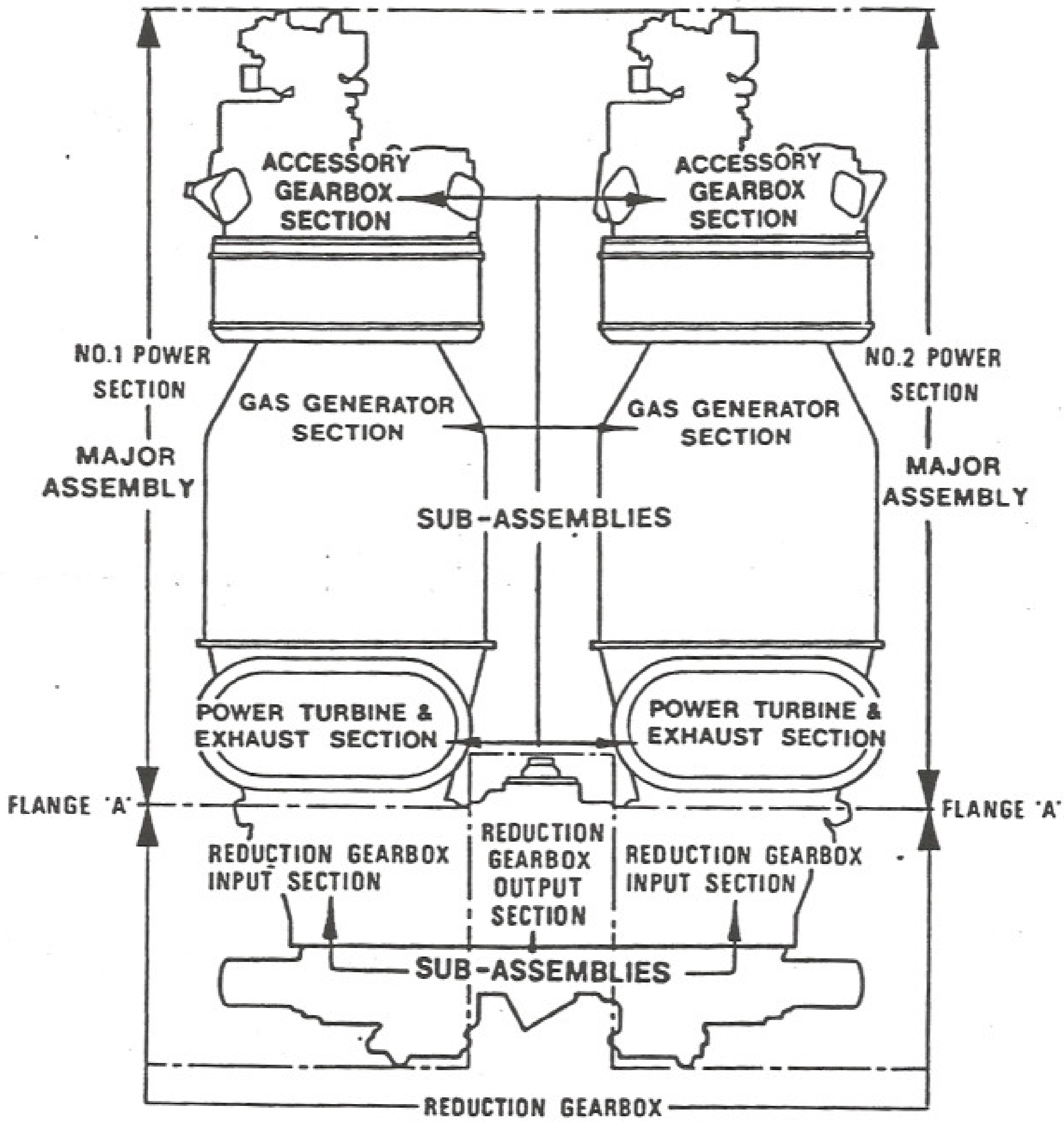
The combustion chamber is an annular, reverse flow type unit with various sized perforations for entry of compressed air into the combustion chamber. Expanding gases of the combustion moves forward, changes direction 180° and passes through the compressor turbine nozzle guide vanes to the compressor turbine. The expanding gases from the compressor turbine pass rearward through the power turbine nozzle guide vanes to the power turbine. The exhaust gases from the power turbine is directed through the exhaust plenum into the air management system bypass air, into the atmosphere.

MAJOR DIVISIONS

There are three major divisions of the PT6T-3 powerplant installation; two power sections, left and right; and a single reduction gearbox.

An accessory gearbox section mounts to the front of each power section, and houses the input shaft from the power section and the reduction gearing for the tachometer generator, fuel control unit and starter-generator. Each gearbox contains the oil reservoir and pumps for the lubrication system of the accessory gearbox, the power section input section of the reduction gearbox.

MAJOR DIVISIONS



The two power sections are identical free-power turbine turboshaft engines. Each power section uses two separate turbines, a gas producer turbine to drive the compressor and accessory gearbox, and a free-power turbine to drive the turbine shaft that is coupled to the power output shaft to the reduction gearbox. Each power section is composed of a compressor inlet case, compressor assembly, gas generator case, combustion chamber and turbines, and the exhaust duct.

The two power sections drive a single gearbox output shaft to the transmission through separate halves of a common reduction gearbox, often referred to as a combining gearbox, combining the output of both power sections into one. The reduction gearbox provides a 5:1 reduction of the power turbine speed to output shaft speed by means of a three-stage gear train for each power section. Each power section reduction gearing contains a sprag clutch unit that drives in one direction only, so that with one power section inoperative, the sprags disconnect the inoperative power section.

FUEL SYSTEM

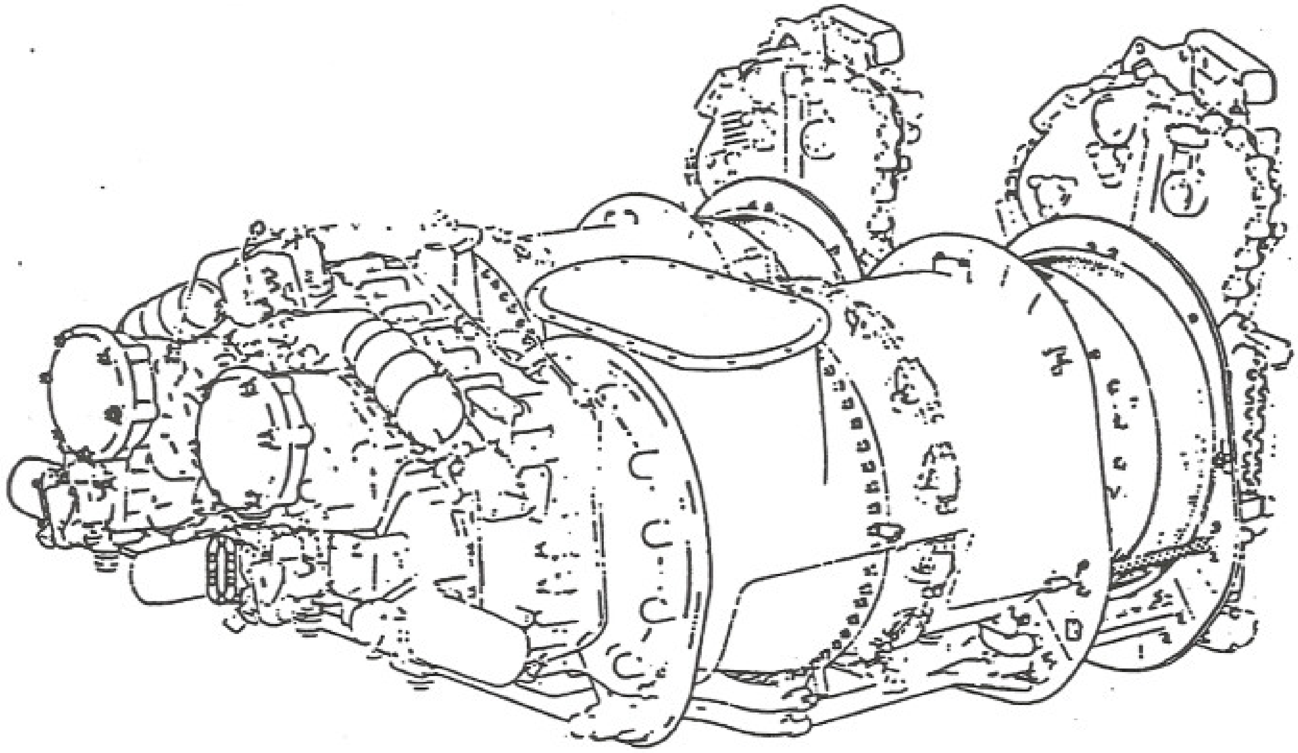
The powerplant fuel system consists of separate but identical power section hydro-pneumatic fuel control systems and fuel pumps, with a common torque control unit. Each power section fuel system is made up of a fuel pump, a manual fuel control unit, and automatic fuel control unit, power turbine governor, flow divider, manifolds and nozzles.

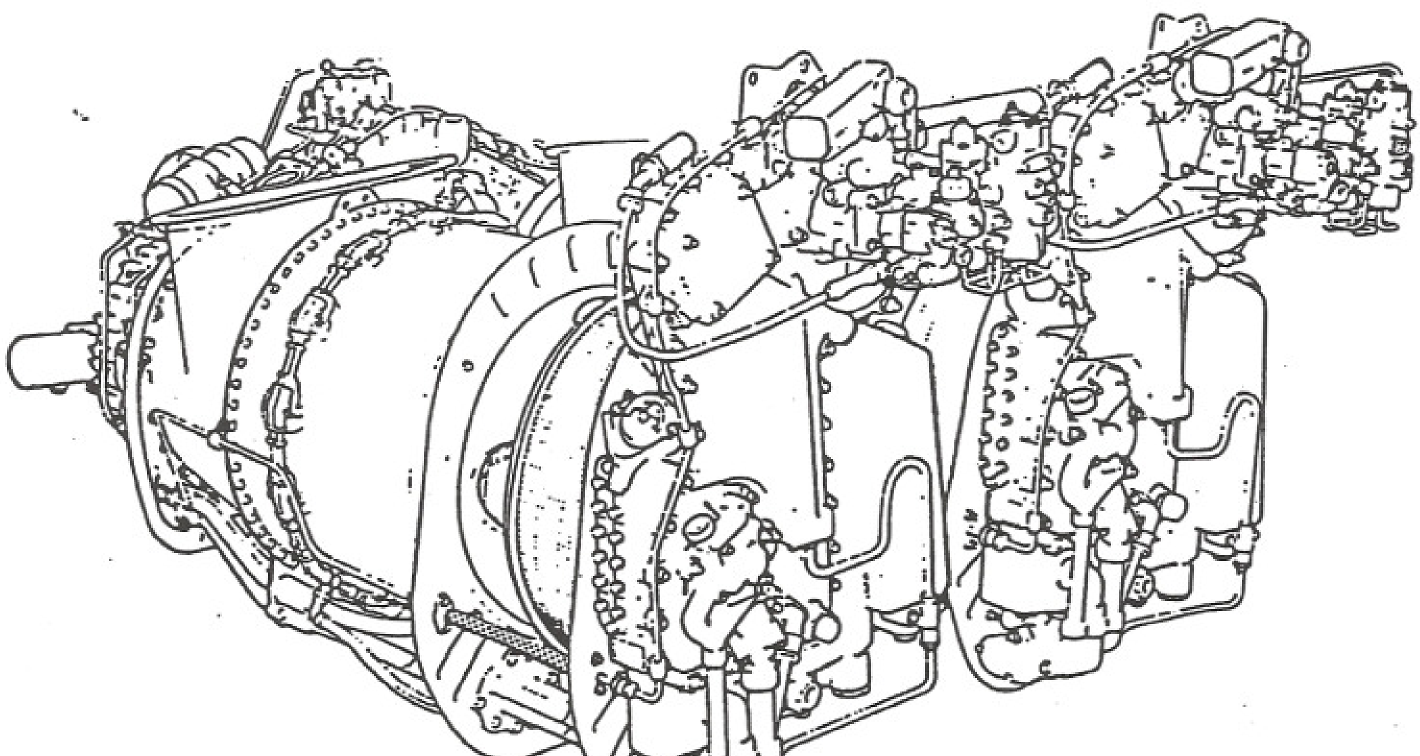
The fuel pump is a positive displacement gear-type unit with a 10 micron pleated paper fuel filter mounted on the pump body. The output of the pump in excess of power section requirements is returned to the inlet.

The manual fuel control unit is mounted with the fuel pump and automatic fuel control unit on the accessory gearbox. Its function, normally, is to pass fuel from the pump to the automatic fuel control, and from the automatic fuel control to the flow divider. It has a transfer valve, combination metering valve and shut-off valve controlled by the power control throttle lever, a pressurizing valve and bypass valve.

The automatic fuel control establishes the proper fuel schedule, in response to the power requirements, by controlling the speed of the gas producer turbine.

PT6T-3B TWINNED TURBOSHAFT ENGINE





AIRBLEED SYSTEM

Each power section contains an interstage airbleed system to provide anti-stall characteristics by dumping a part of the compressed air from the compressor 3rd stage vane assembly. A bleed valve mounted on the gas generator case at the 5 o'clock position controls dumping of the air.

IGNITION SYSTEM

Each power section has its own separate ignition system, consisting of an ignition exciter, shielded igniter plug cables, and two igniter plugs.

POWER LEVER CONTROL SYSTEM

The power lever controls system consists of two parallel mechanical linkages, connecting the dual control twist grip of the collective stick to the manual fuel control units on the accessory drive sections. The linkages extend down through the collective stick to a sector gear, under the cabin floor to the manual fuel control unit on each accessory gearbox. The upper twist grip is the Engine #1 control, the lower is the Engine #2 control. A flight idle stop is in the linkage on the work deck to prevent inadvertant shut-down of the power section when retarding the twist grips.

POWER TURBINE GOVERNOR CONTROL SYSTEM

The linkage for the power turbine governors of each power section consists of a mechanical input from the collective pitch control through a droop compensator, an electrical linear actuator control for speed selection, and a jackshaft to the power turbine governors for control of power turbine speed of both power sections. The droop compensator maintains and stabilizes the pre-selected N_f RPM by changing governor control as collective pitch is increased or decreased. The linear actuator provides control of N_f RPM selection by changing the position of the lever on the power turbine governors.

Notes

The power turbine governor for each power section is mounted on the rear of the reduction gearbox, driven at a speed proportional to the power turbine speed. It causes a change in governor reset air to the automatic fuel control to change the compressor speed when it senses a power turbine speed change.

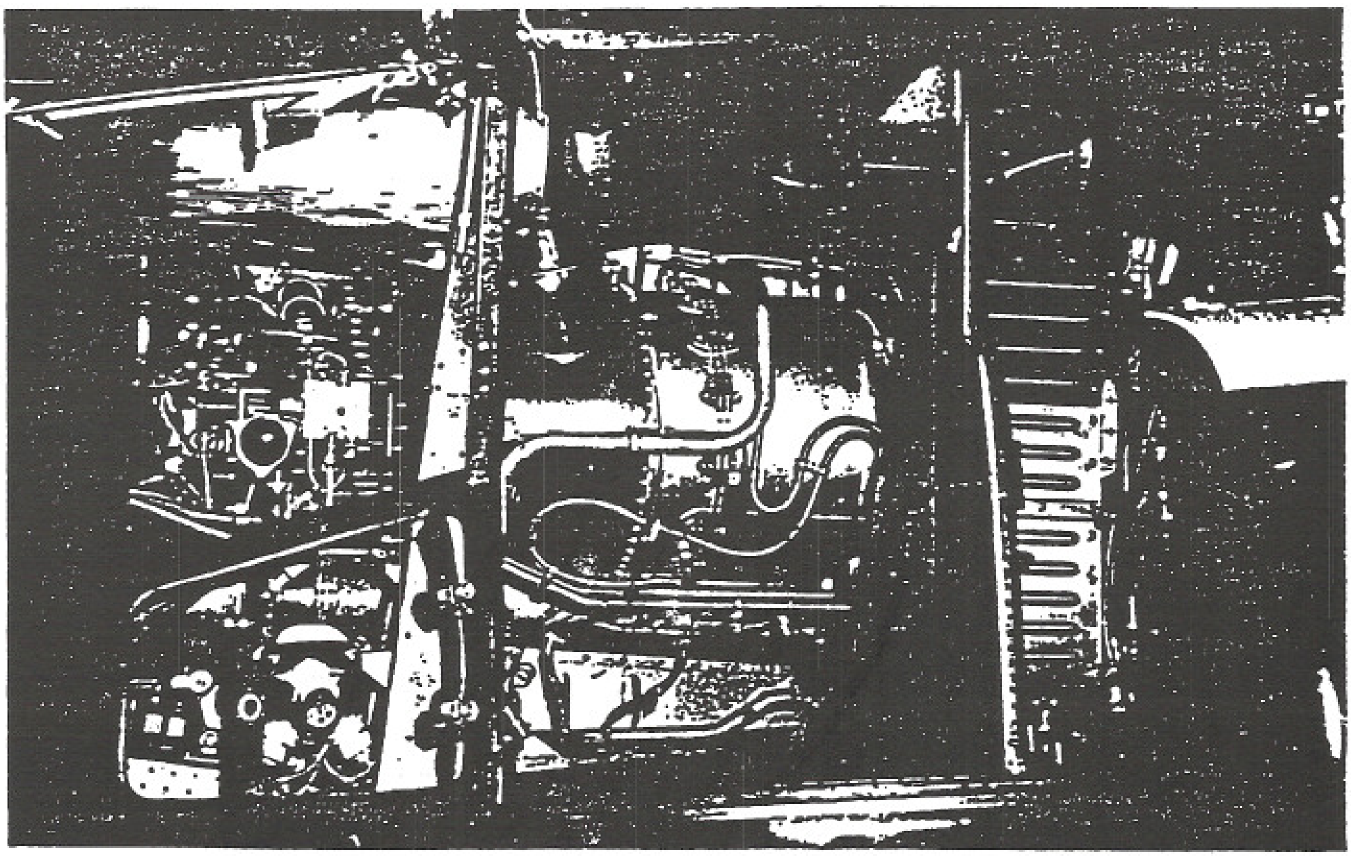
A single torque control unit mounted on the reduction gearbox receives torque-meter pressure from each power section and by controlling the governor reset air both limits the total torque output and maintains equal torque output of the two power sections.

A flow divider is mounted on the gas generator case to provide metered fuel to the primary and secondary manifolds and the 14 simplex fuel nozzles.

LUBRICATION SYSTEMS

The PT6T-3 powerplant has three separate lubrication systems, identical systems provide lubrication for the two power sections, accessory gearbox sections and their respective input sections of the reduction gearbox. A third oil system provides lubrication for the output sections of the reduction gearbox.

Integral oil tanks and oil pumps, oil filters, visual oil level indicators, filters and drain facilities are provided for each oil system. Individual oil coolers are provided aft of the powerplant for each system, with two blowers driven by the reduction gear train of each power section.



Power Plant — Right Side View

POWER SECTION AIRFLOW

Inlet air from the air management system enters each power section through a circular plenum chamber formed by the compressor inlet case, and is directed to the compressor.

The compressor consists of three axial stages and a single centrifugal stage of compression, acting as a single integral unit. Compressed air from the centrifugal compressor passes through diffuser pipes and straightening vanes to the combustion chamber.

The combustion chamber is an annular, reverse flow type unit with various sized perforations for entry of compressed air into the combustion chamber. Expanding gases of the combustion moves forward, changes direction 180° and passes through the compressor turbine, pass rearward through the power turbine nozzle guide vanes to the power turbine. The exhaust gases from the power turbine is directed through the exhaust plenum into the air management system bypass air, into the atmosphere.

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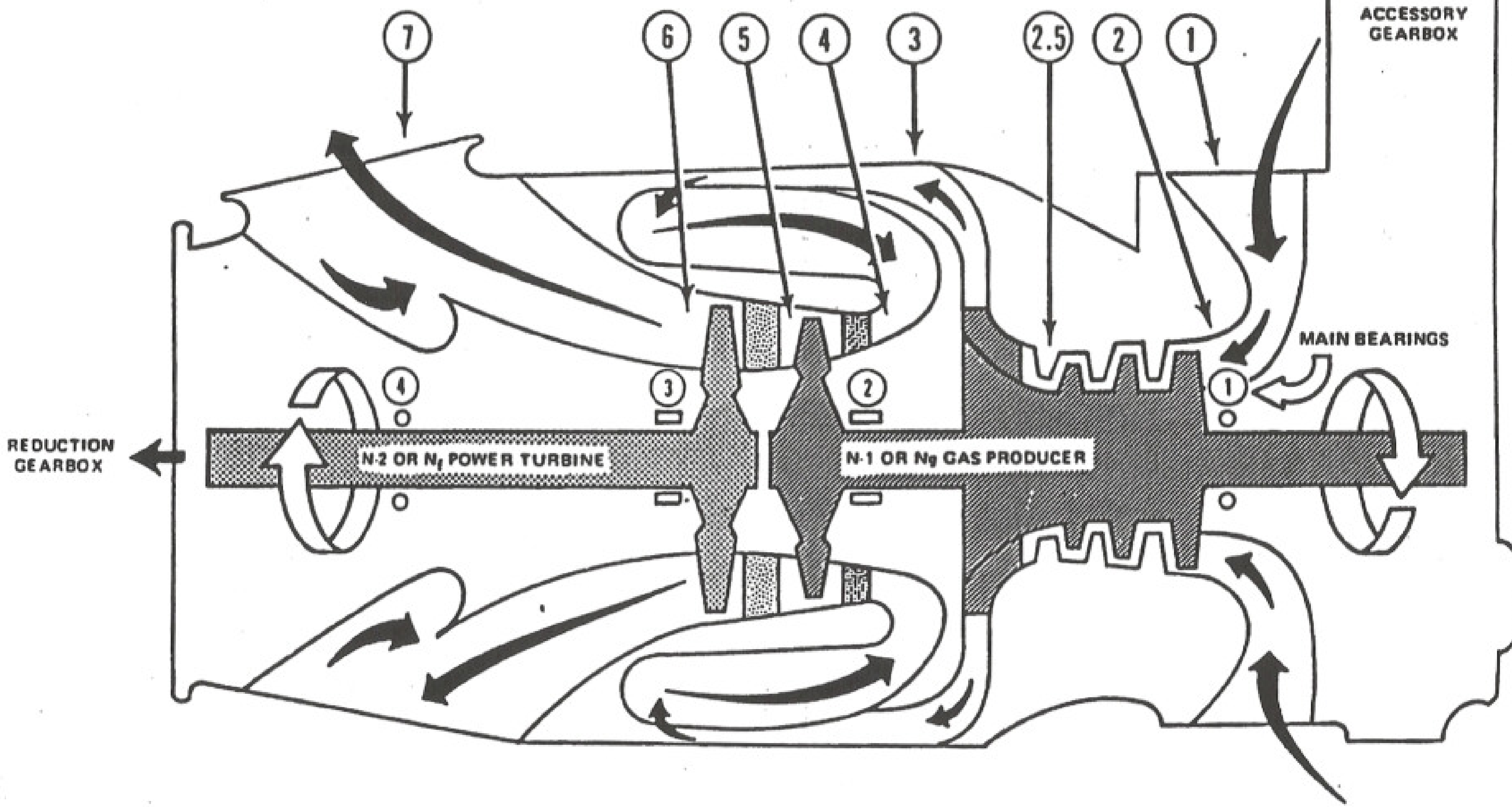
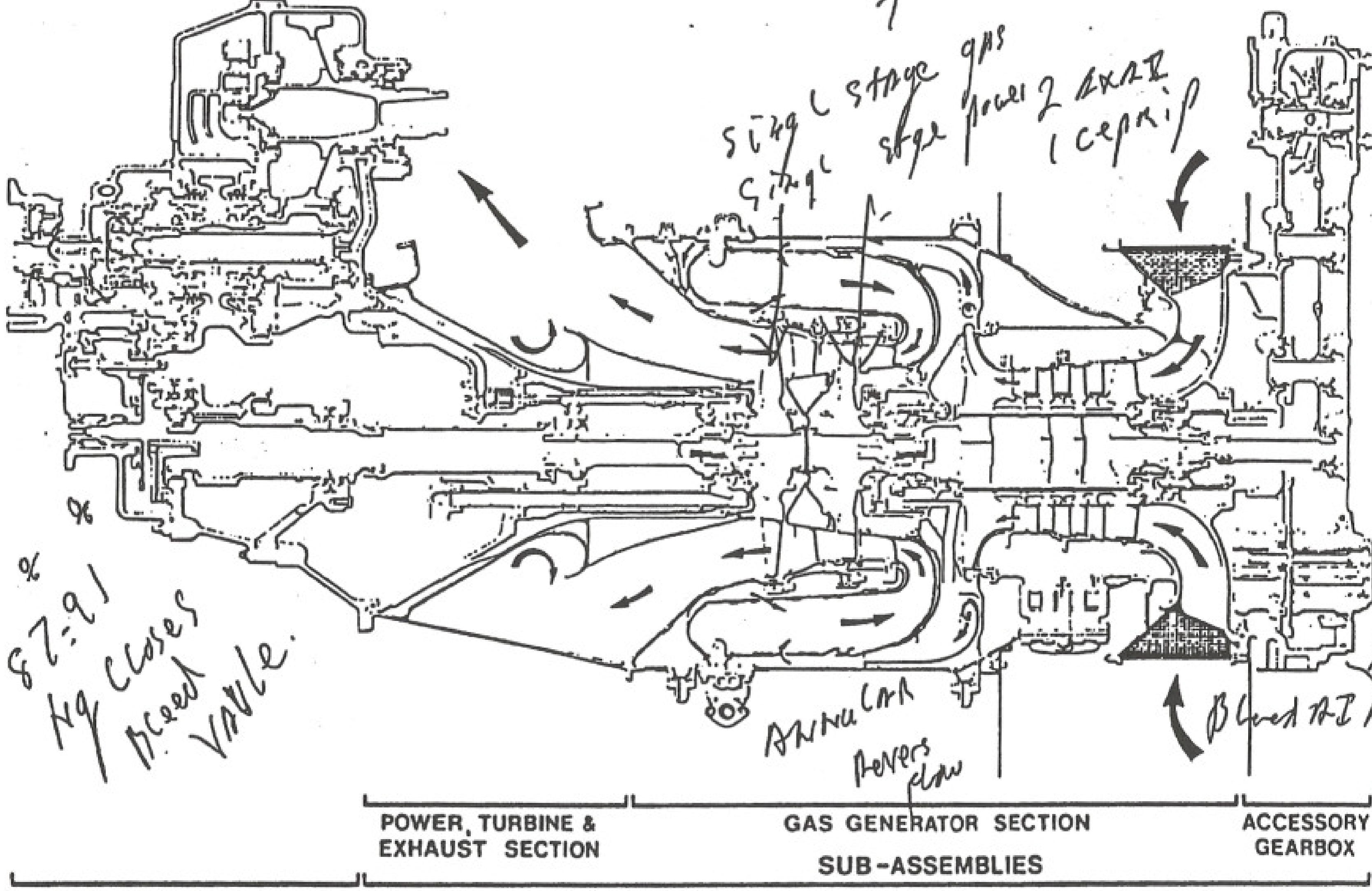
POWER SECTION SCHEMATIC

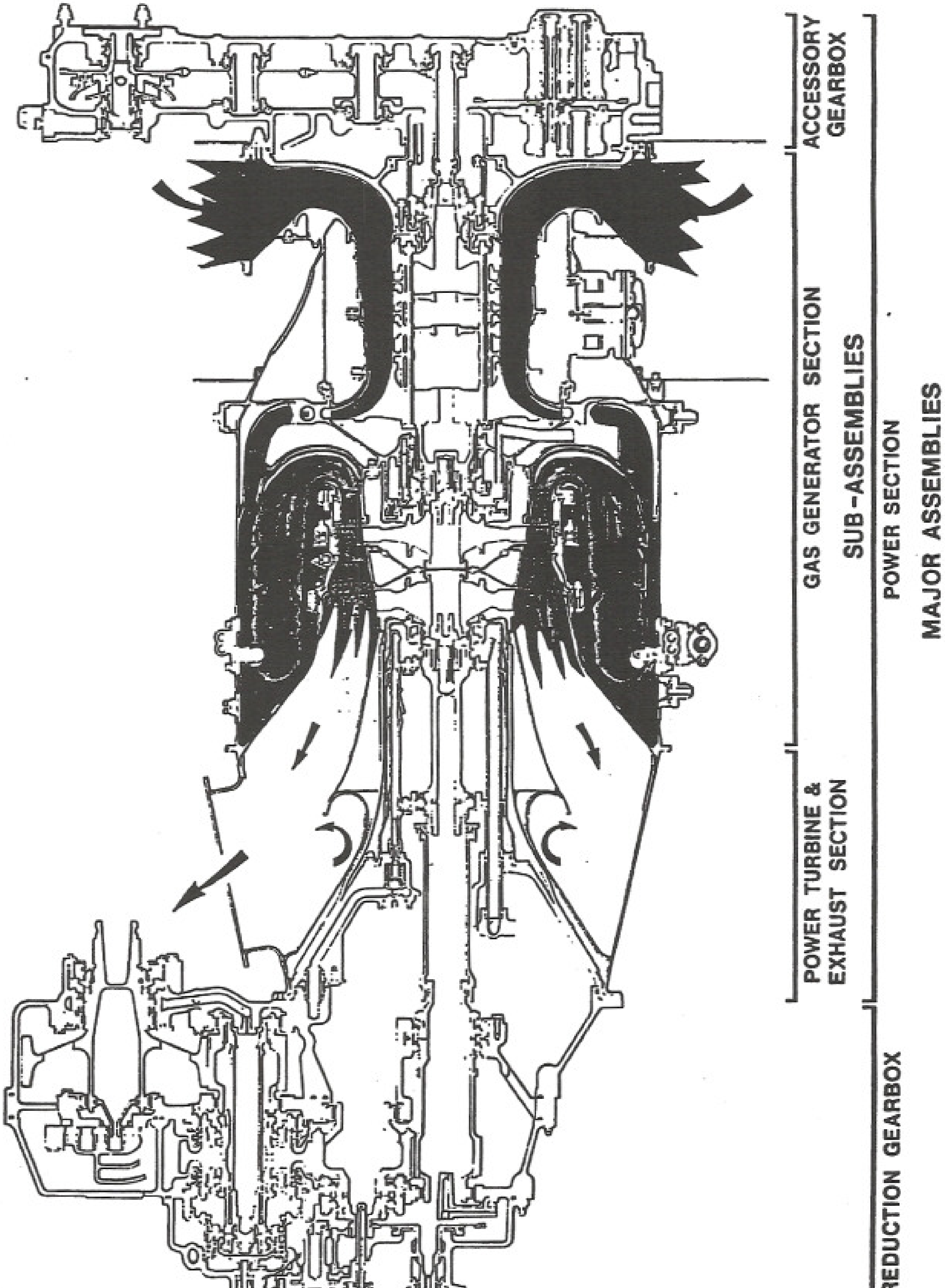
STATIONS

1 . . . . Air Inlet
2 . . . . Compressor Inlet
2.5 . . . . Interstage (P2.5)
3 . . . . Compressor Discharge (Burner Case) (P3)
4 . . . . Turbine Inlet
5 . . . . Inter-Turbine (T5)
6 . . . . Turbine Outlet (T6)
7 . . . . Exhaust Outlet (T7)

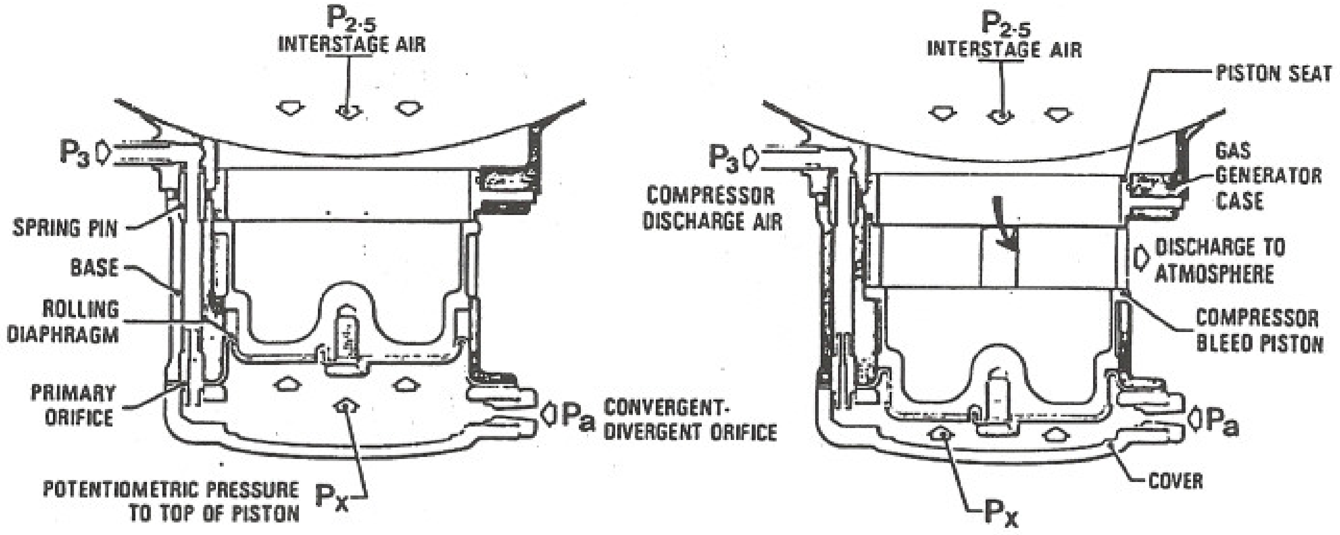




POWER SECTION AIRFLOW/CROSS SECTION

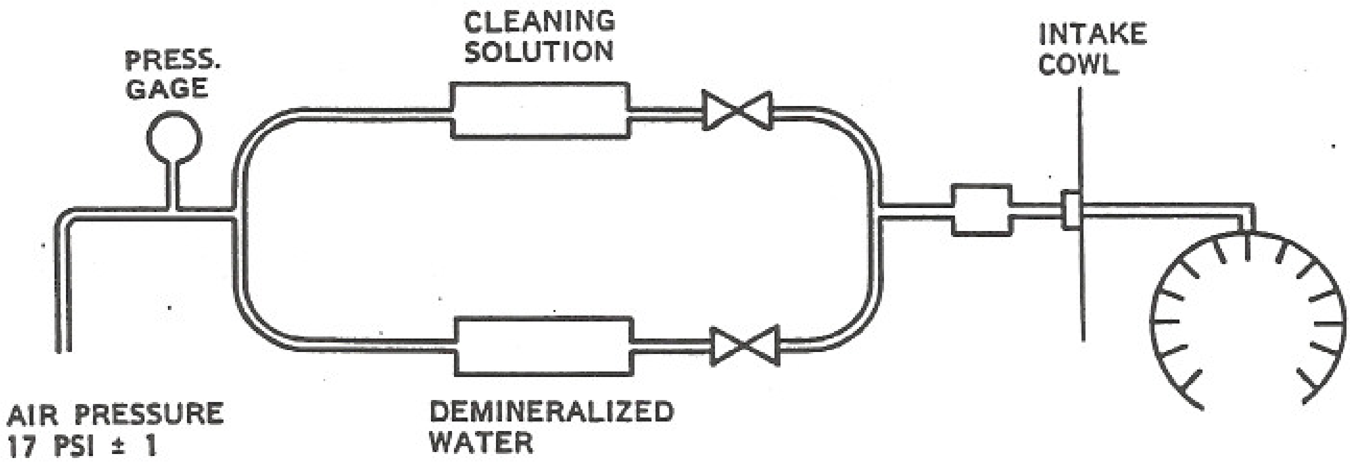


Engine Cross–Section



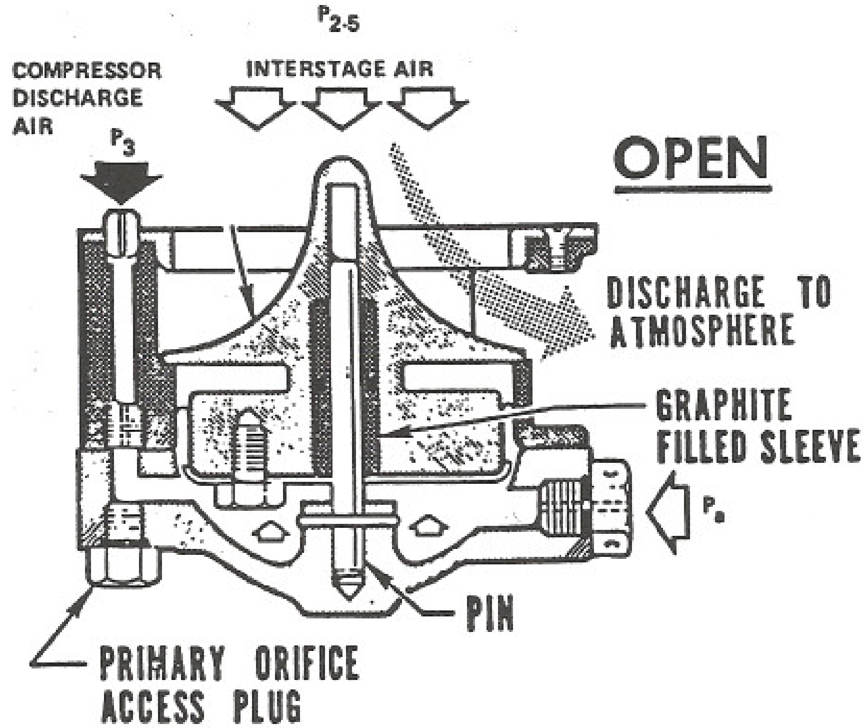
Compressor Bleed Valve Schematic

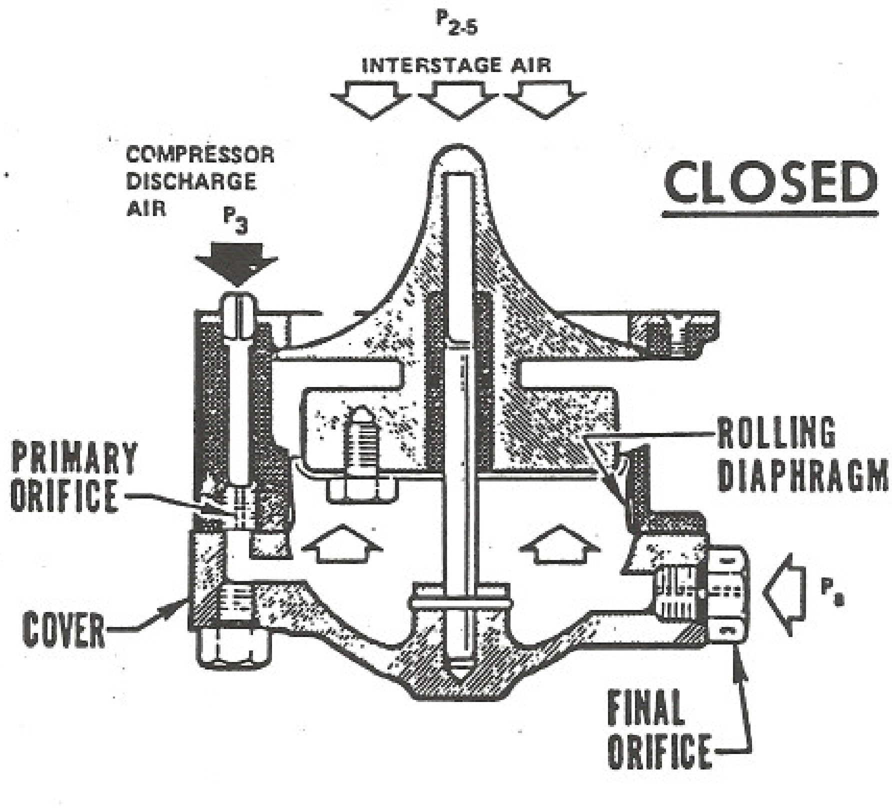
Notes



Compressor Washing Schematic

Notes





Compressor Bleed Valve Schematic

COMPRESSOR BLEED VALVE

Each power section contains an interstage airbleed system to provide anti-stall characteristics by dumping a part of the compressed air from the compressor 3rd stage vane assembly. A bleed valve mounted on the gas generator case at the 5 o'clock position controls dumping of the air.

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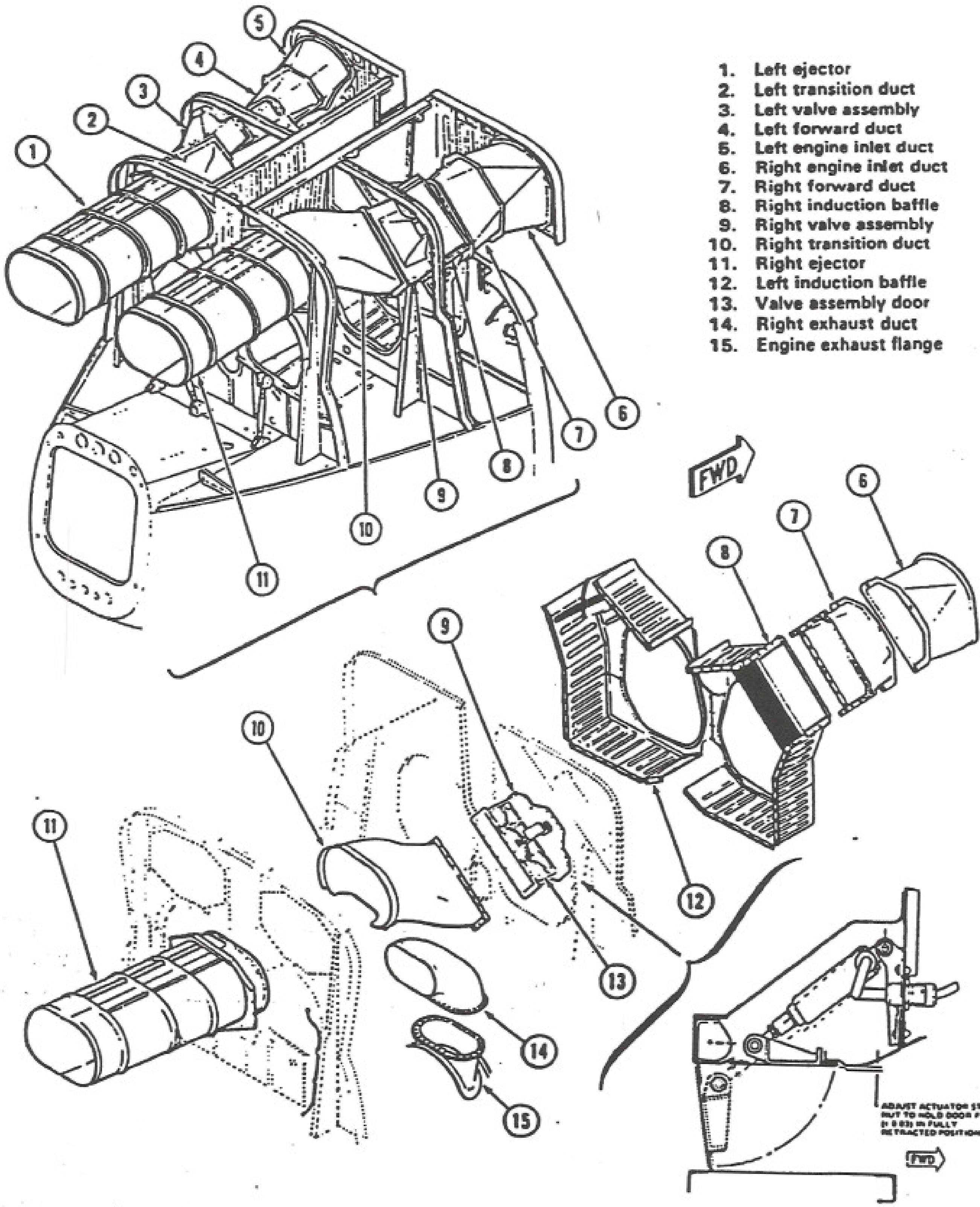
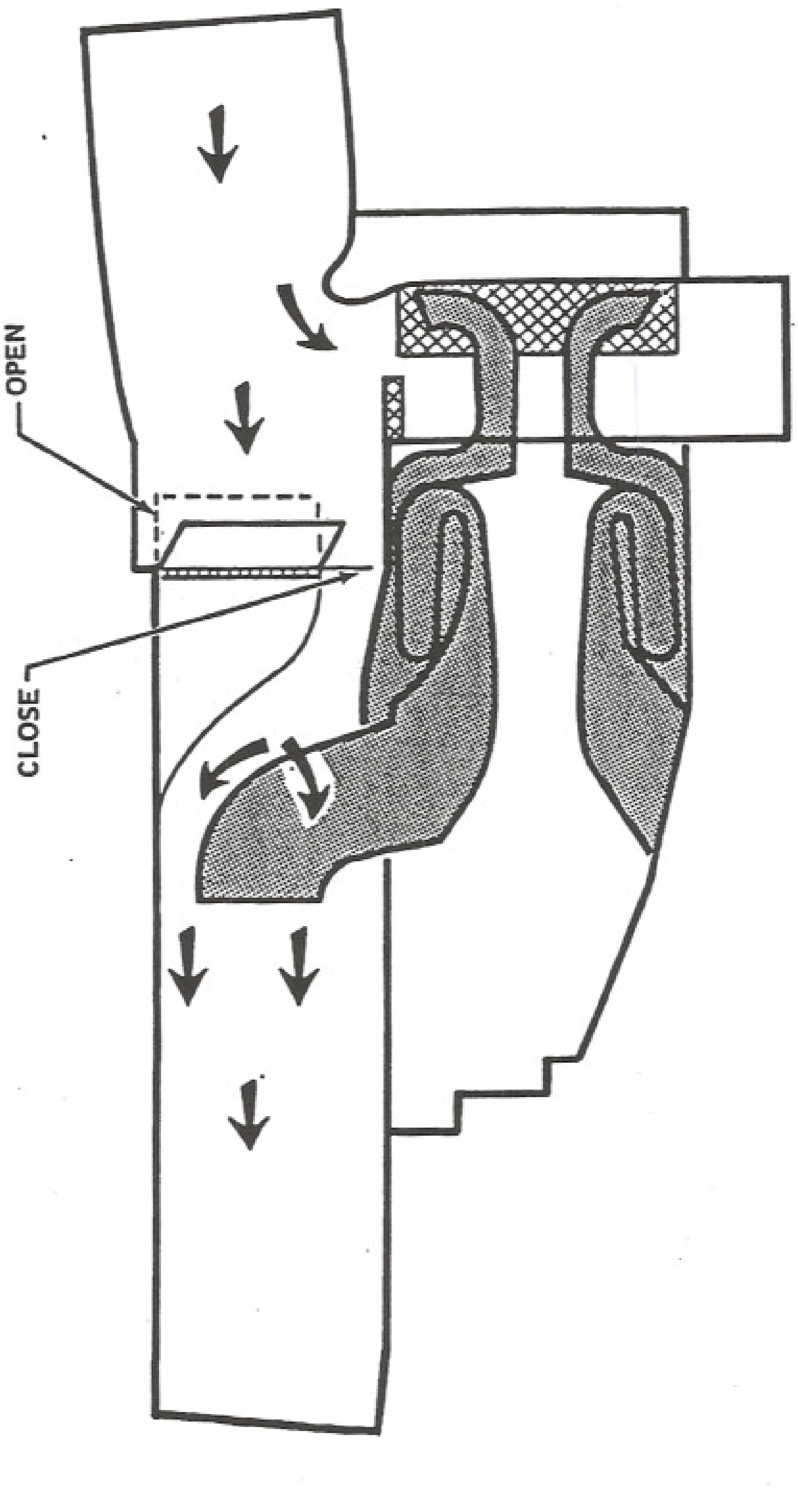
AIR MANAGEMENT SYSTEM INSTALLATION



1. Left ejector
2. Left transition duct
3. Left valve assembly
4. Left forward duct
5. Left engine inlet duct
6. Right engine inlet duct
7. Right forward duct
8. Right induction baffle
9. Right valve assembly
10. Right transition duct
11. Right ejector
12. Left induction baffle
13. Valve assembly door
14. Right exhaust duct
15. Engine exhaust flange

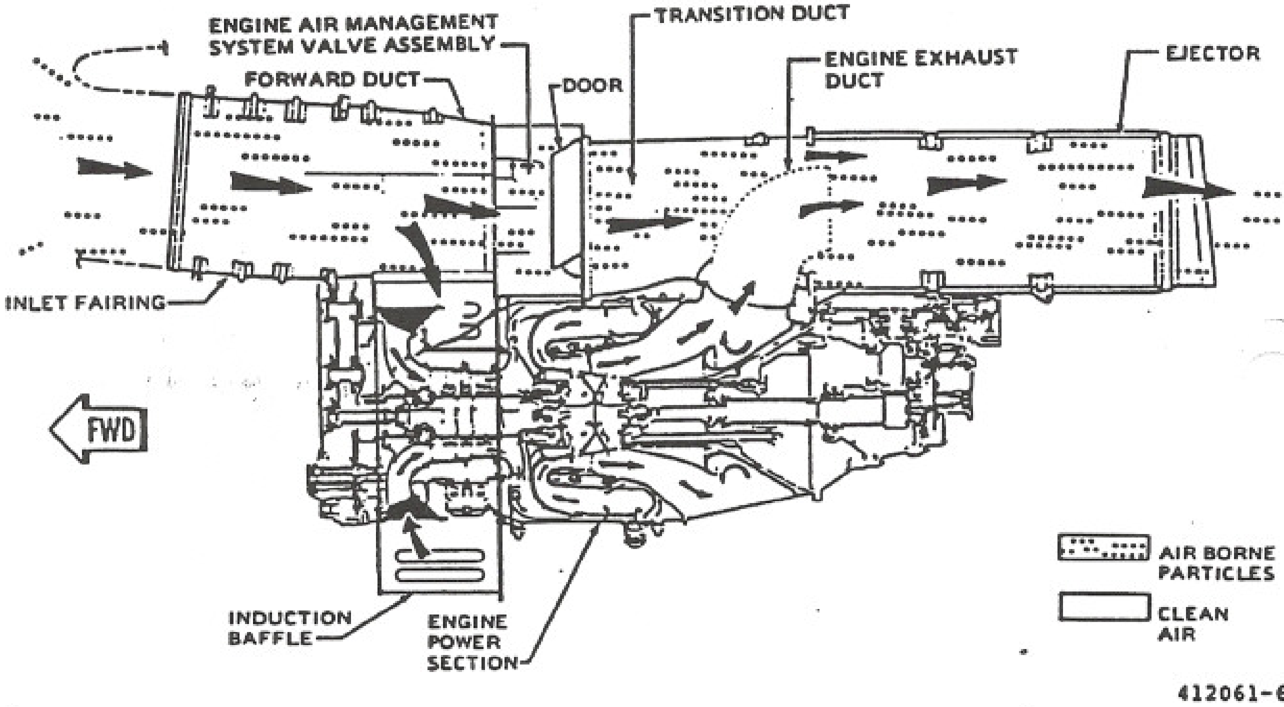


PARTICLE SEPARATOR SYSTEM

AIR MANAGEMENT SYSTEM

The air management system is a dual system of ducts and valves to provide inlet air to each power section, and through an ejector, carries away exhaust gases. Control of the airflow to the ejector is provided by a two position control valve, downstream of the engine inlet duct. During normal operation, the control valve is open and a portion of the air entering the inlet duct is bypassed to the ejector to carry away most foreign particles.

AIR MANAGEMENT SYSTEM SCHEMATIC



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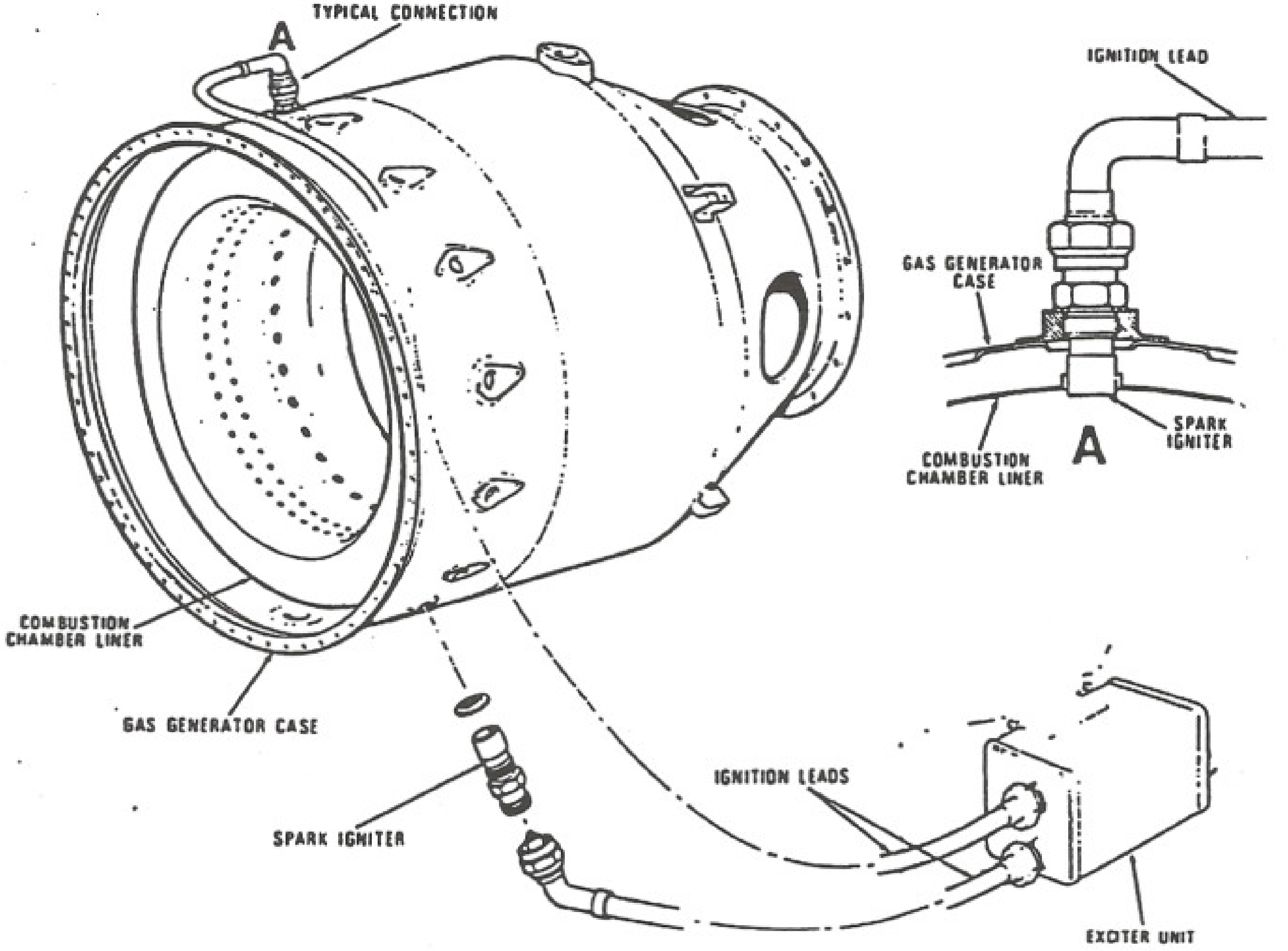
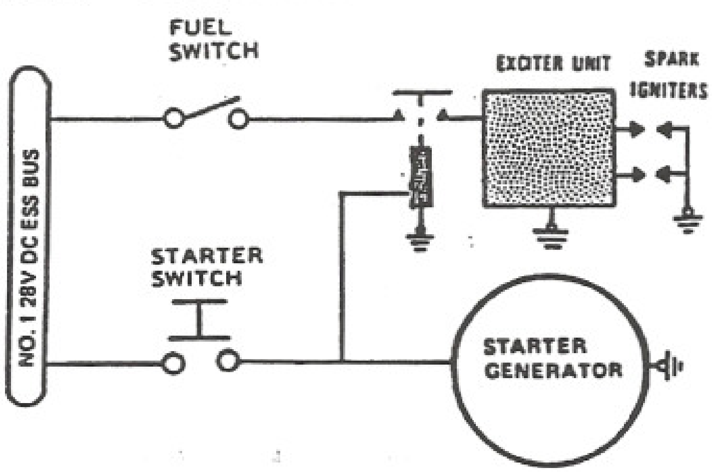
IGNITION SYSTEM INSTALLATION

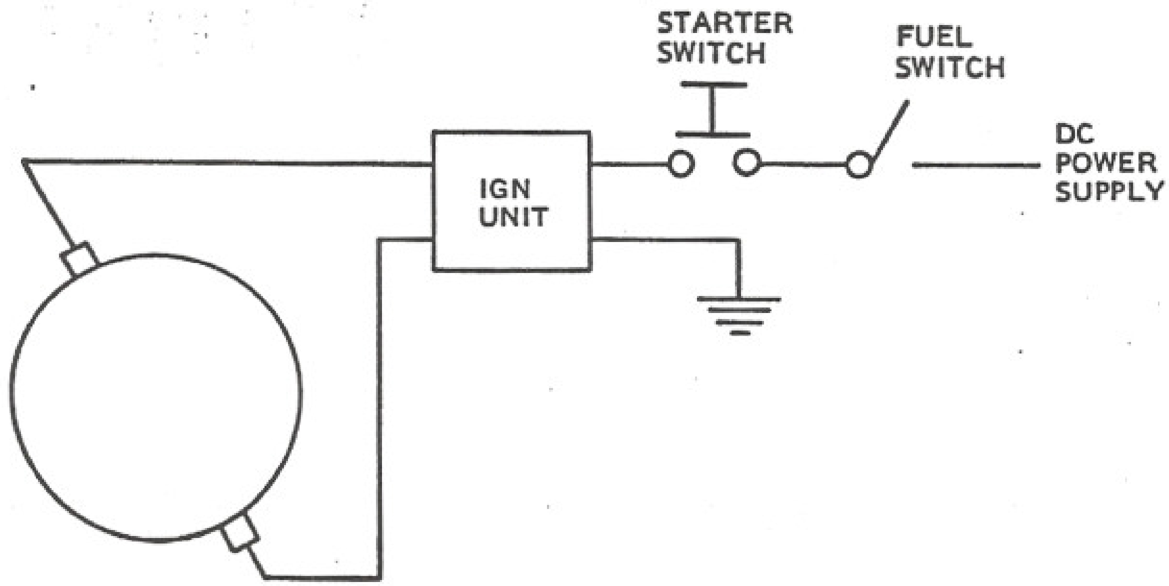


IGNITION SYSTEM — SCHEMATIC



IGNITION SYSTEM

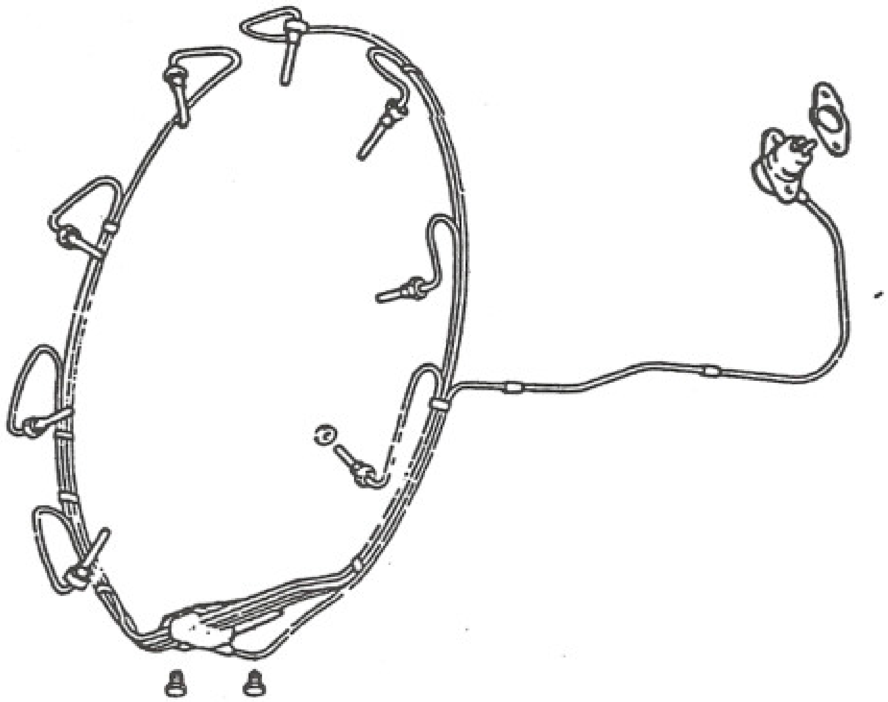
Each power section has its own separate ignition system, consisting of an ignition exciter, shielded igniter plug cables, and two igniter plugs.

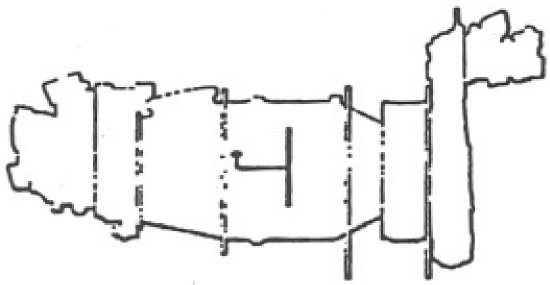


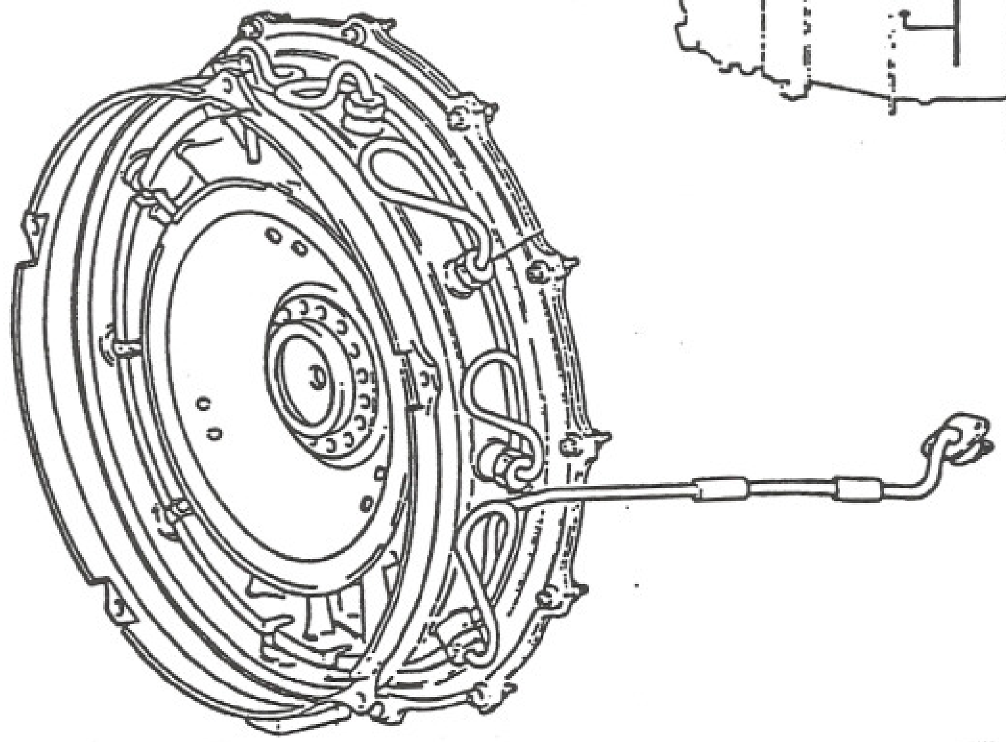
Ignition System Schematic

Notes

T5 INTERTURBINE TEMPERATURE THERMOCOUPLE



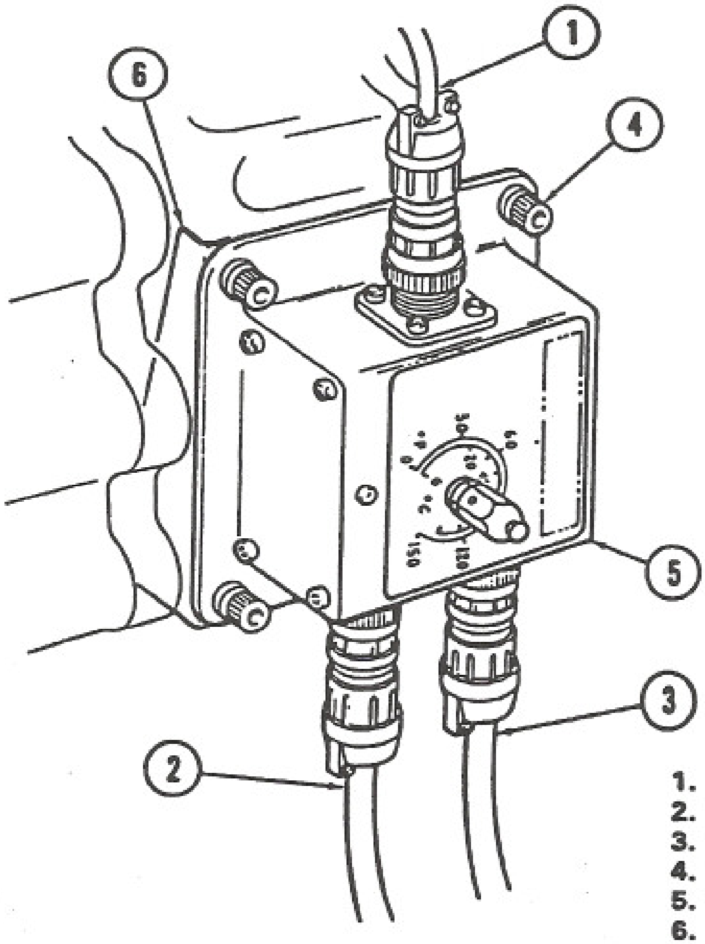




INTER-TURBINE TEMPERATURE AND COMPENSATOR

Inter-turbine temperature is sensed by eight Chromel-Alumel probes located between the gas producer turbine and the power turbine guide vanes. Shielded leads connect the probes to an external terminal block which is connected by leads to a T-5 temperature compensator mounted on the reduction gearbox. The adjustable temperature compensator is used to standardize ITT indications, using power section data plate temperature as a reference.

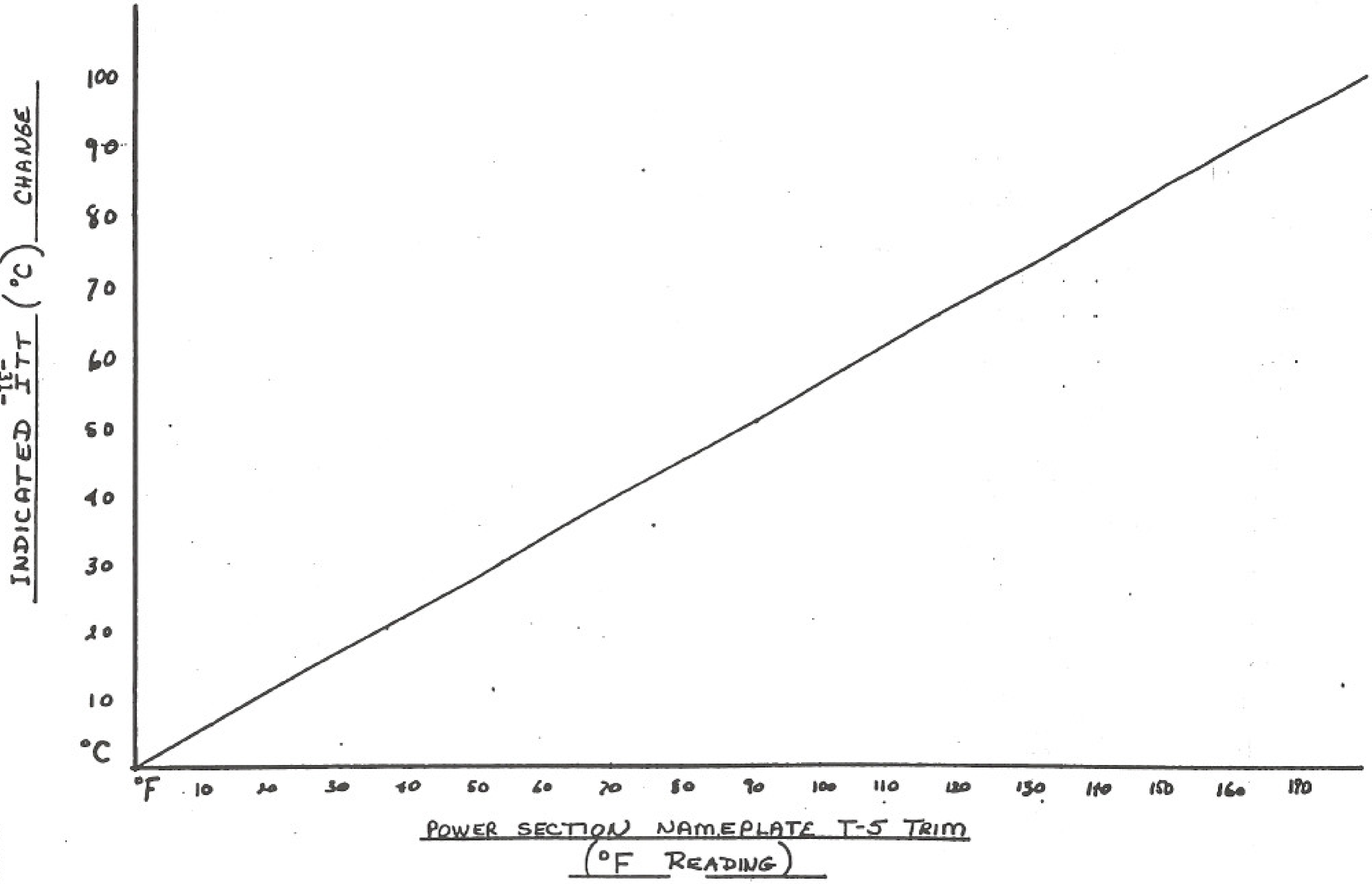
T5 TEMPERATURE COMPENSATOR

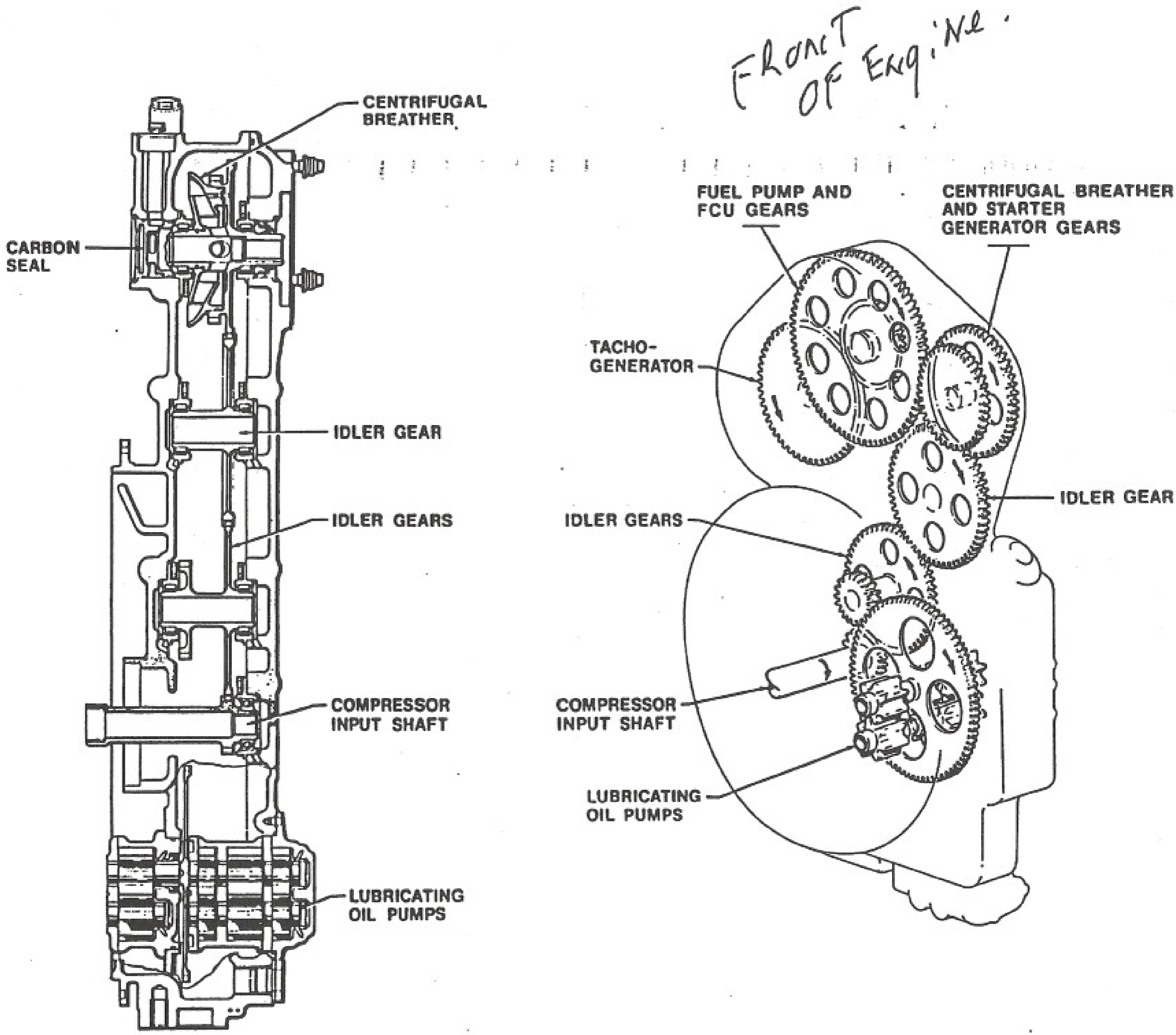


1. Power input cable
2. Thermocouple input cable from T5 system
3. Thermocouple output cable to instrumentation
4. Bolt and self-locking nut
5. Temperature compensator
6. Mounting bracket

PT6T-3

T-5 TRIM CONVERSION CHART



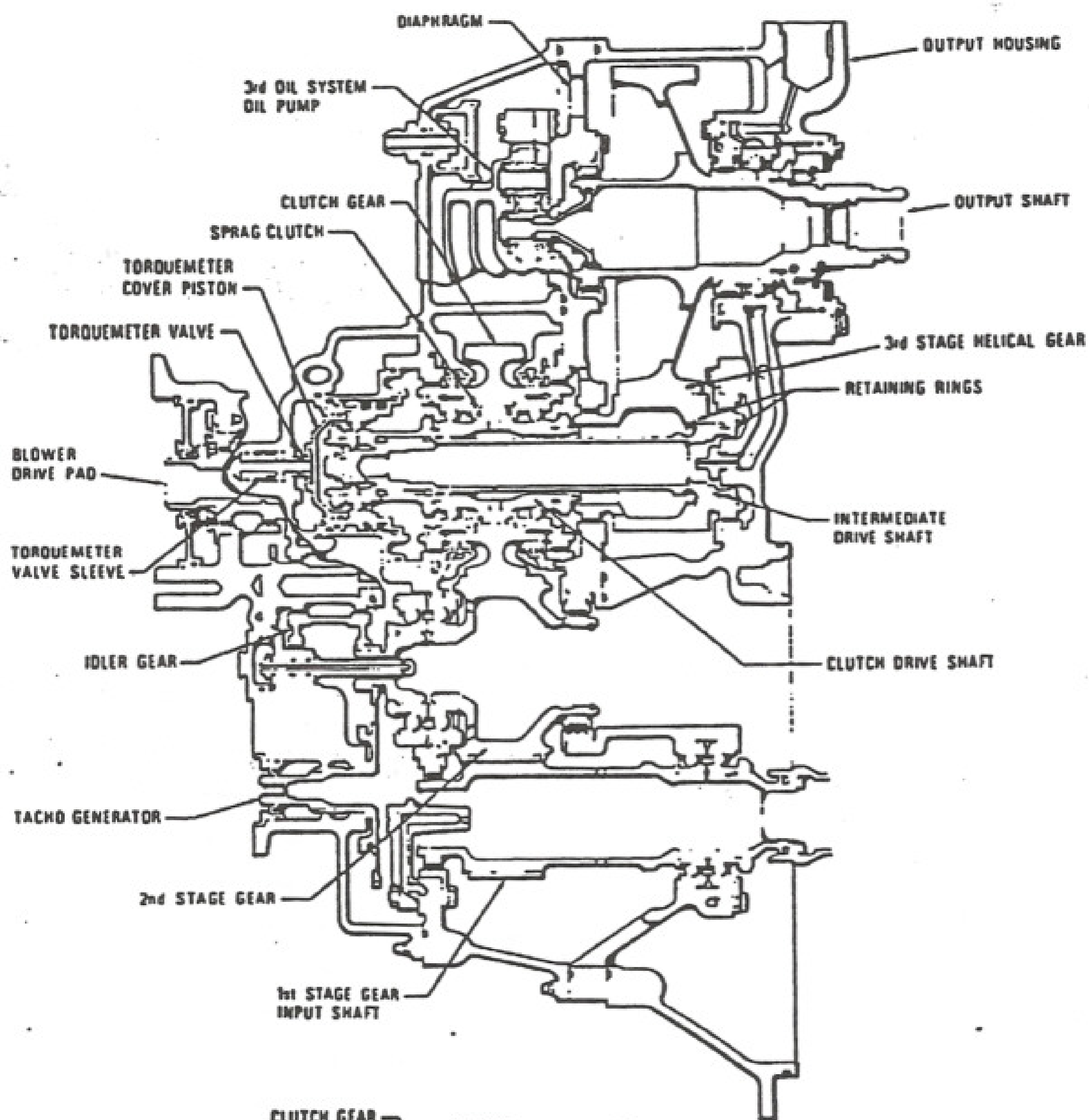


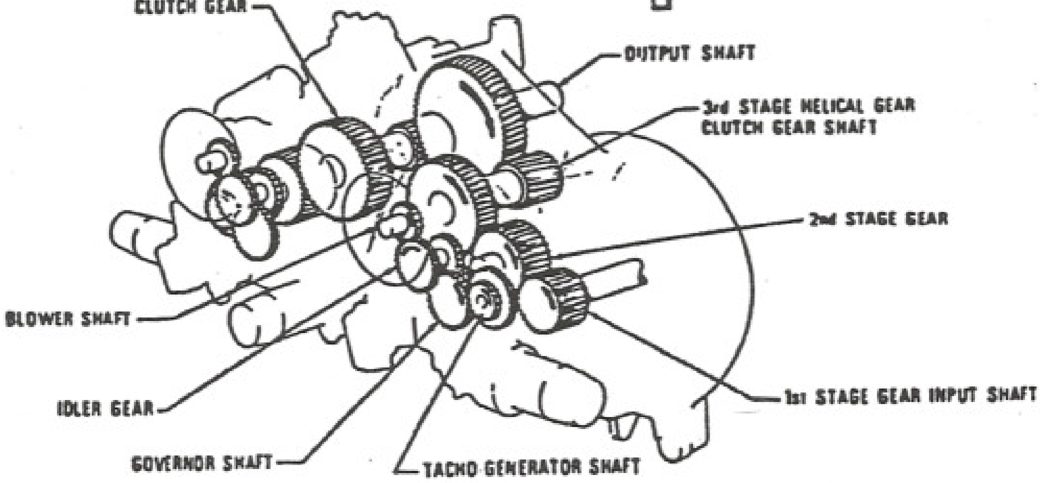
Accessory Gearbox – Schematic

ACCESSORY GEARBOX

An accessory gearbox section mounts to the front of each power section, and houses the input shaft from the power section and the reduction gearing for the tachometer generator, fuel control unit and starter-generator. Each gearbox contains the oil reservoir and pumps for the lubrication system of the accessory gearbox, the power section, and the power section input section of the reduction gearbox.

REDUCTION GEARBOX



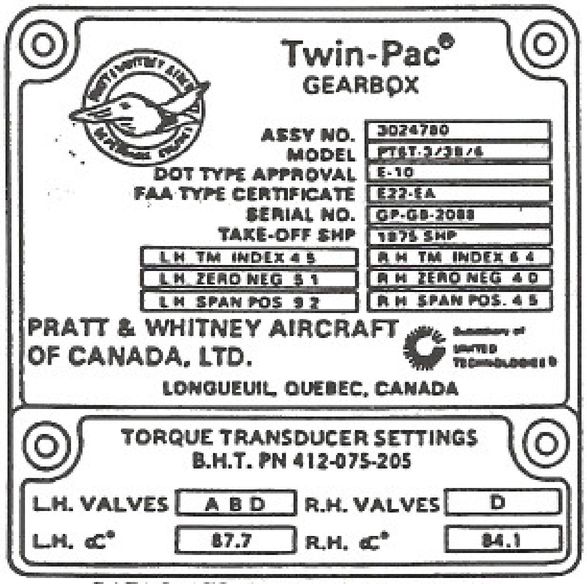


REDUCTION GEARBOX

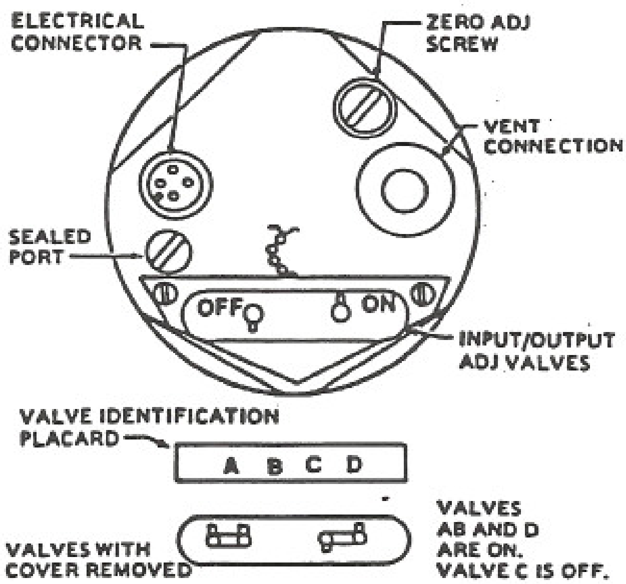
The reduction gearbox, also known as the combining gearbox, provides a 5:1 reduction of the power turbine speed to output shaft speed by means of a three-stage gear train for each power section. Each power section reduction gearing contains a sprag clutch unit that drives in one direction only, so that with one power section inoperative, the sprags disconnect the inoperative power section.

Each gear train drives three accessories; the N_2 power turbine governor, N_2 tachometer generator and an oil cooler blower for that power section. Two torque pressure transmitters and a torque control unit receive torquemeter oil pressure from the gearbox.

TORQUE PRESSURE TRANSMITTER



DATA PLATE (TORQUE TRANSMITTER SETTING INSTRUCTION PLATE)



BOTTOM VIEW OF TORQUE TRANSMITTER
SAMPLE TORQUE TRANSMITTER SETTING

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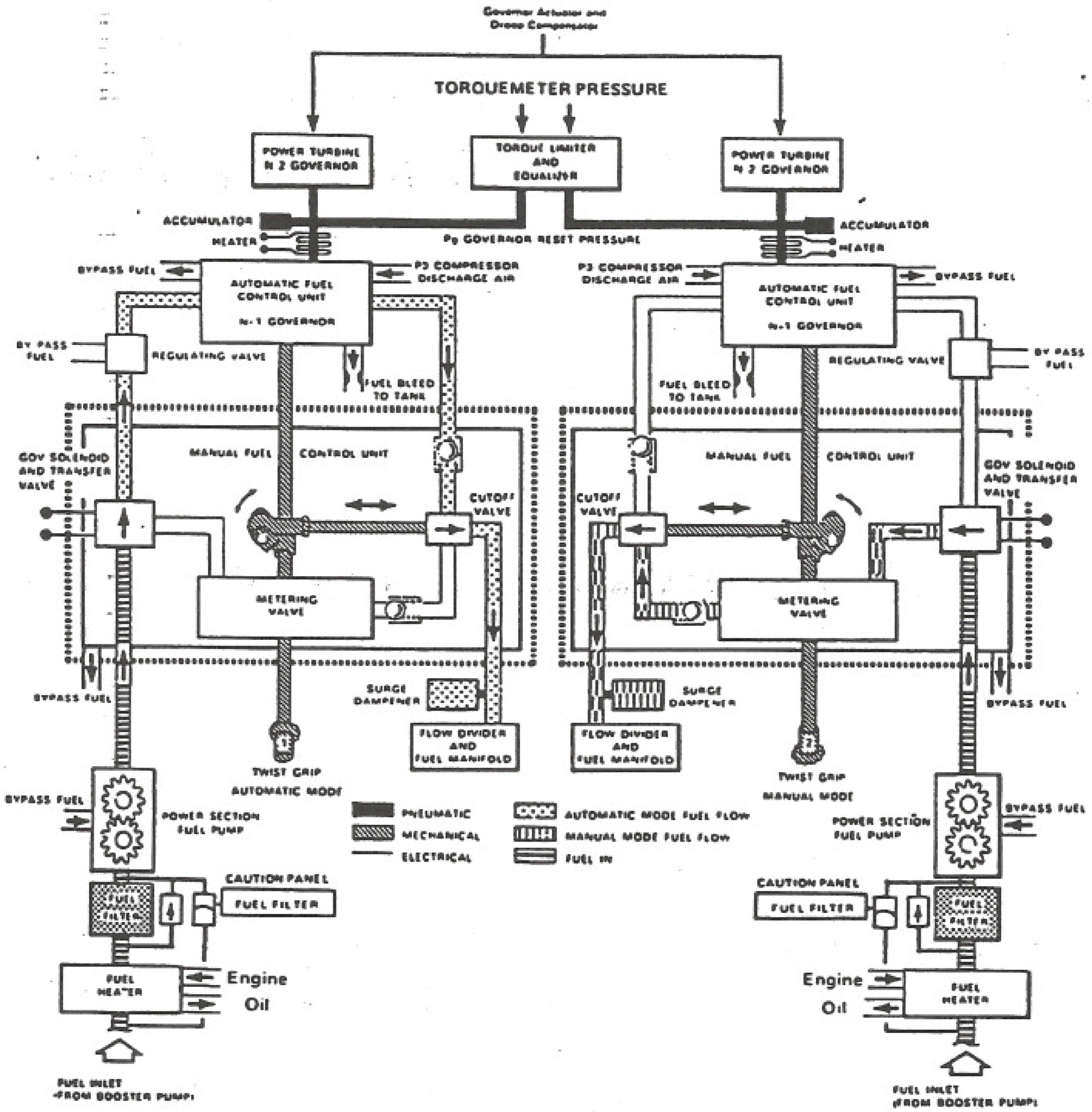
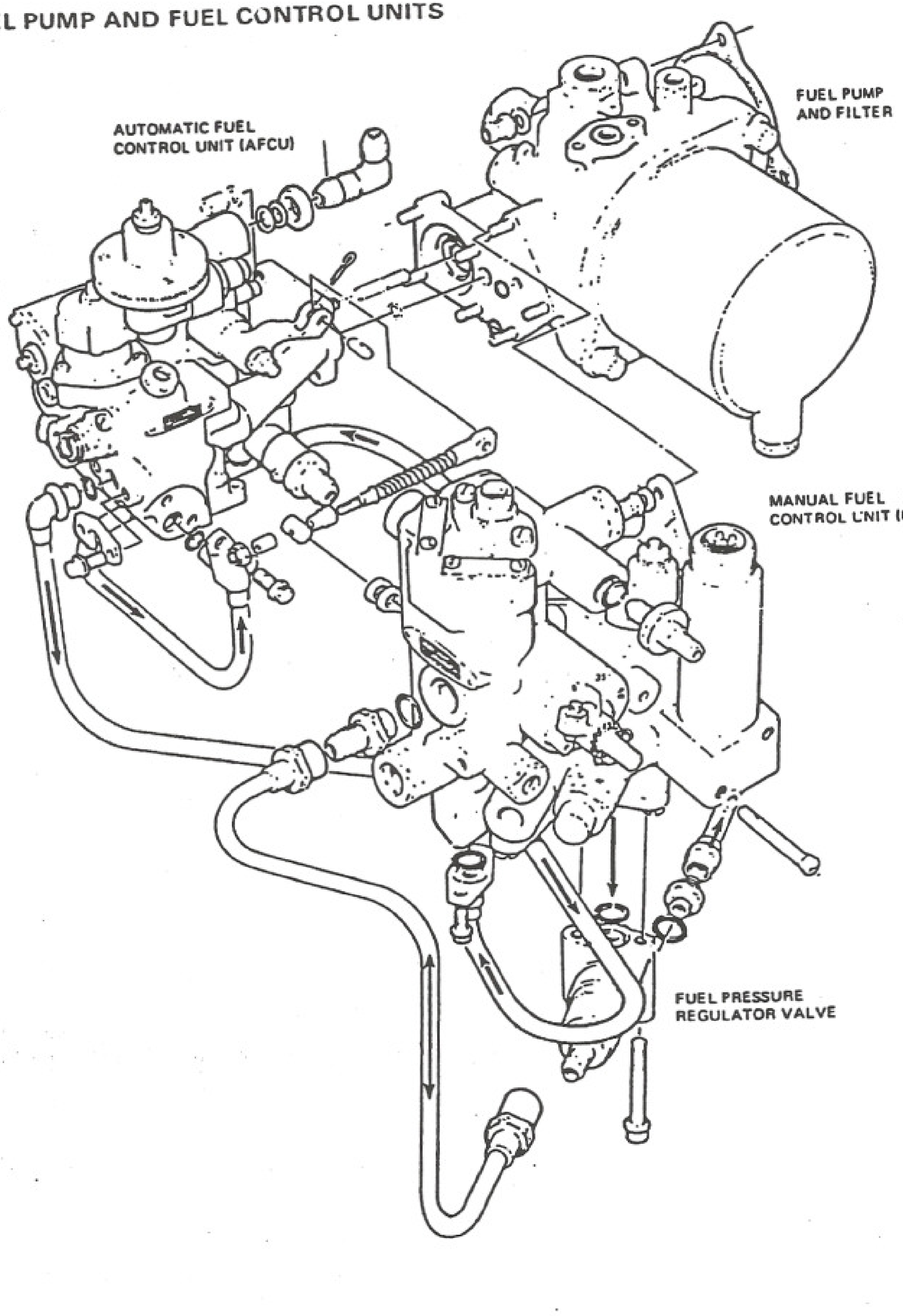
POWER PLANT FUEL SYSTEM



POWERPLANT FUEL SYSTEM

The powerplant fuel system consists of separate but identical power section hydro-pneumatic fuel control systems, with a common torque control unit. Each power section fuel system is made up of a fuel pump, a manual fuel control unit, and automatic fuel control unit, power turbine governor, flow divider, manifolds and nozzles.

FUEL PUMP AND FUEL CONTROL UNITS



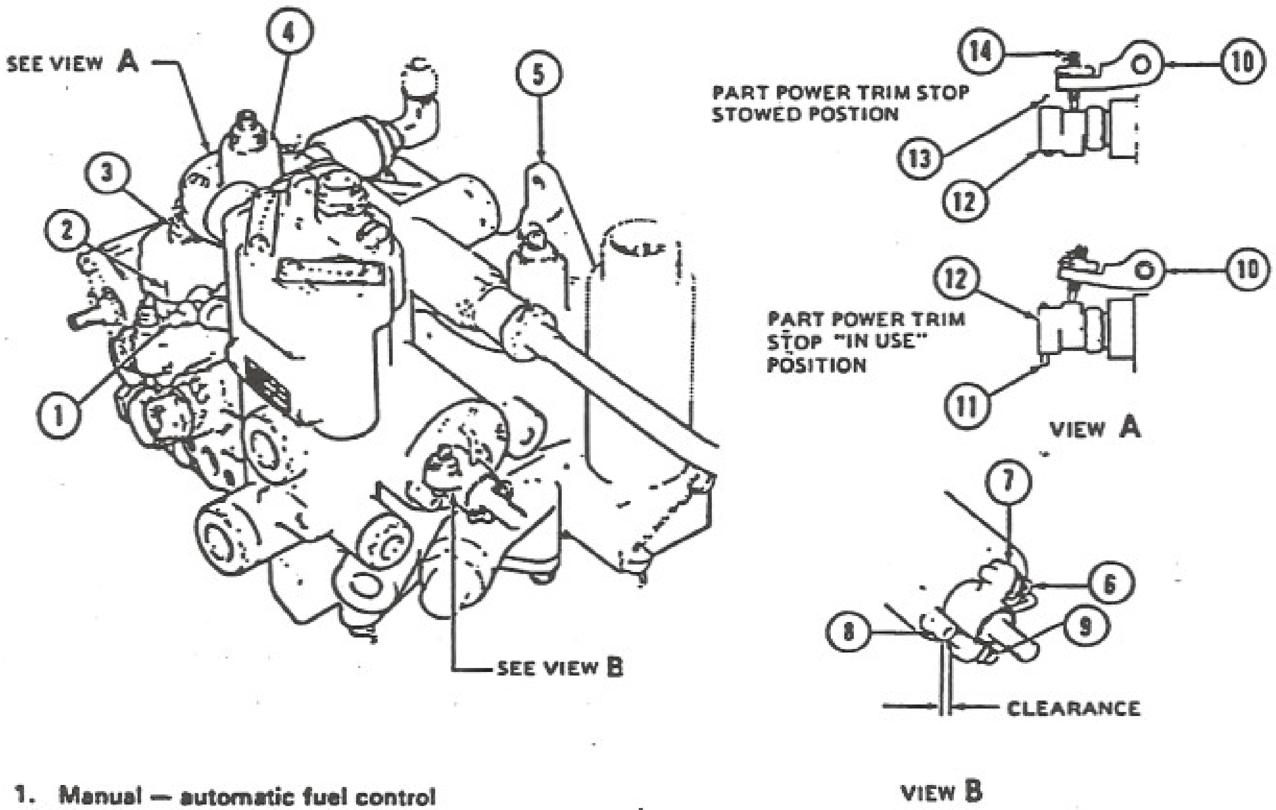
FUEL PUMP AND FUEL CONTROL UNITS

The fuel pump is a positive displacement gear-type unit with a 10 micron pleated paper fuel filter mounted on the pump body. The output of the pump in excess of power section requirements is returned to the inlet.

The manual fuel control unit is mounted with the fuel pump and automatic fuel control unit on the accessory gearbox. Its function, normally, is to pass fuel from the pump to the automatic fuel control, and from the automatic fuel control to the flow divider. It has a transfer valve, combination metering and shut-off valve controlled by the power control throttle lever, a pressurizing valve and bypass valve.

The automatic fuel control mounted to and driven by the fuel pump, establishes the proper fuel schedule, in response to the power requirements, by controlling the speed of the gas producer turbine.

FUEL CONTROL ADJUSTMENTS



1. Manual — automatic fuel control interconnect linkage
2. Datum line
3. Specific gravity adjuster
4. Automatic fuel control
5. Manual fuel control
6. Minimum stop screw, manual fuel control
7. Stop arm, manual fuel control
8. Stop, manual fuel control
9. Maximum stop screw, manual fuel control
10. Fuel control arm, automatic fuel control
11. Cotter pin
12. Part power trim stop
13. Cotter pin
14. Maximum stop adjustment screw, automatic fuel control

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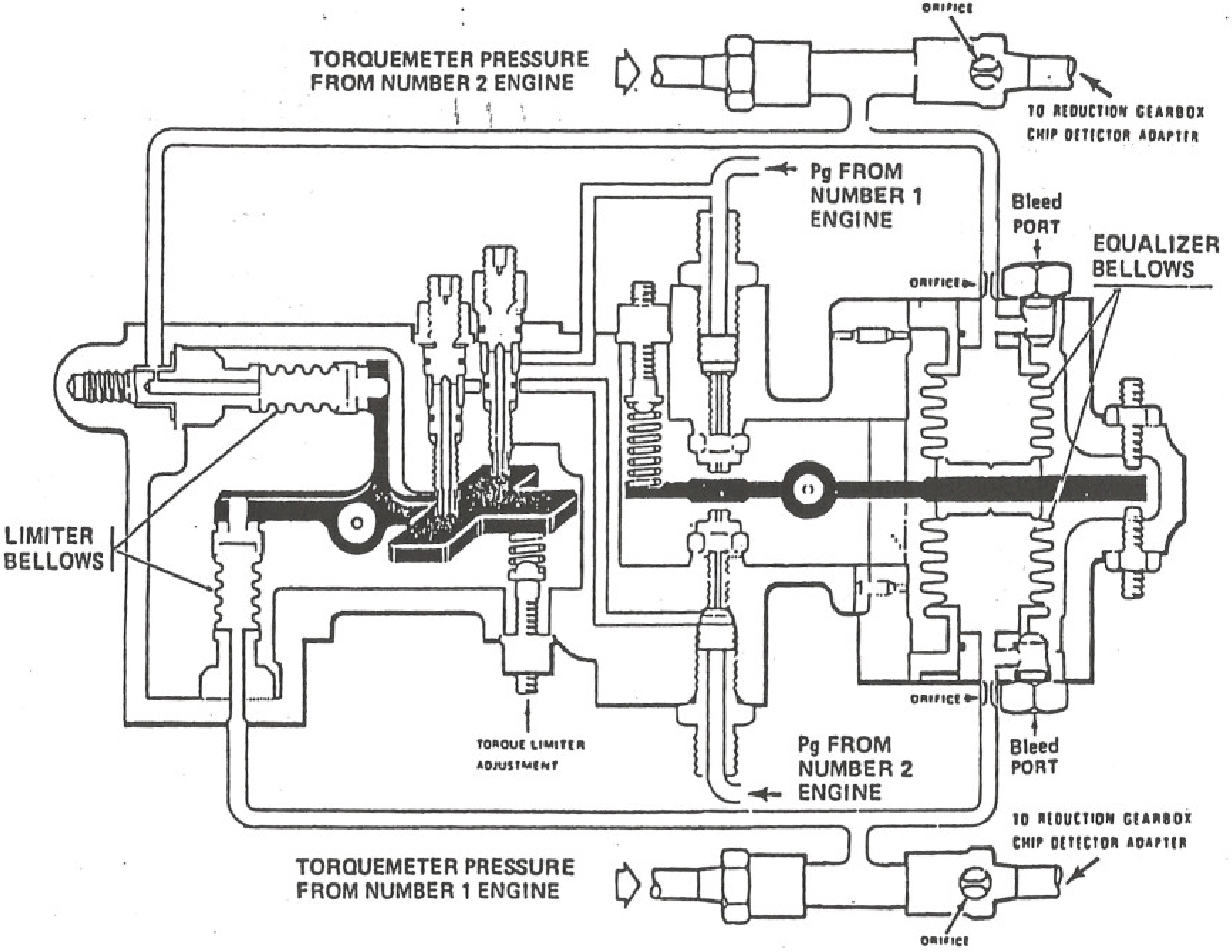
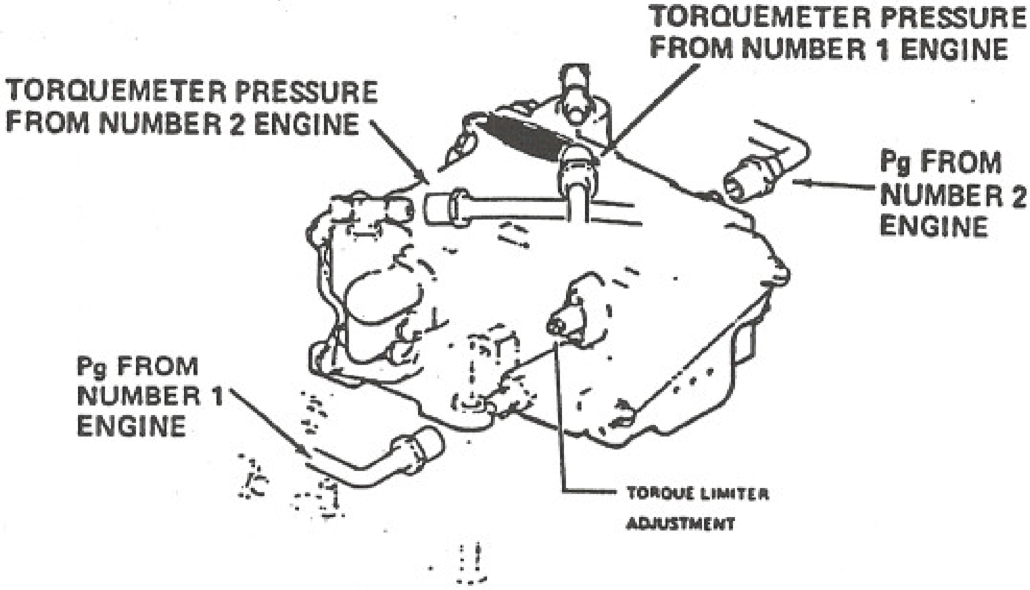
TORQUE CONTROL UNIT SCHEMATIC



TORQUE CONTROL UNIT

A single torque control unit mounted on the reduction gearbox receives torque-meter pressure from each power section and by controlling the governor reset air, both limits the total torque output and maintains equal torque output of the two power sections.

TORQUE CONTROL UNIT



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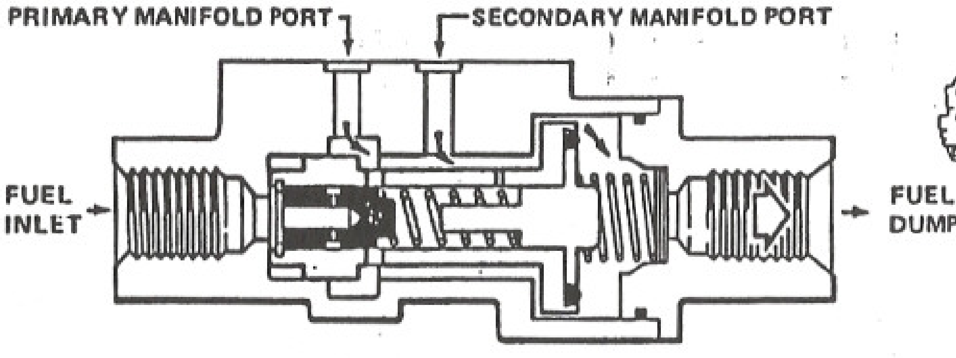
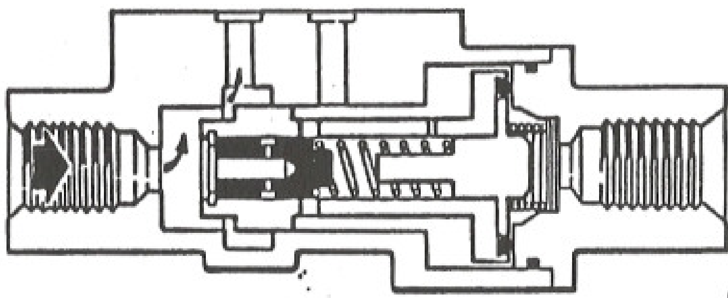
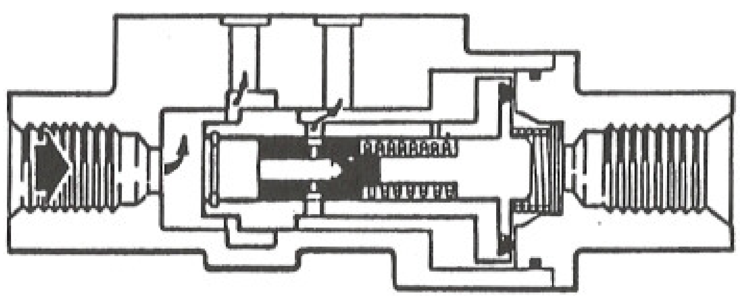
FUEL FLOW DIVIDER



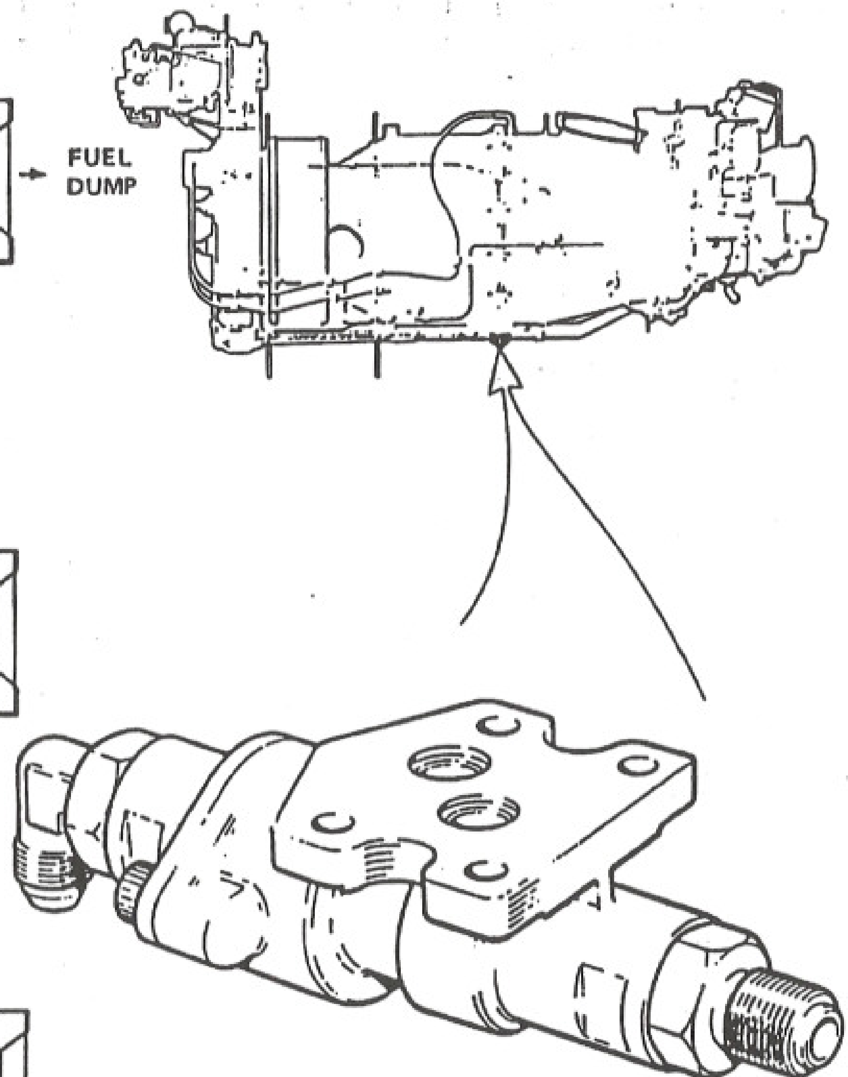
DUMP POSITION



TO PRIMARY MANIFOLD POSITION
12 – 14% N-1



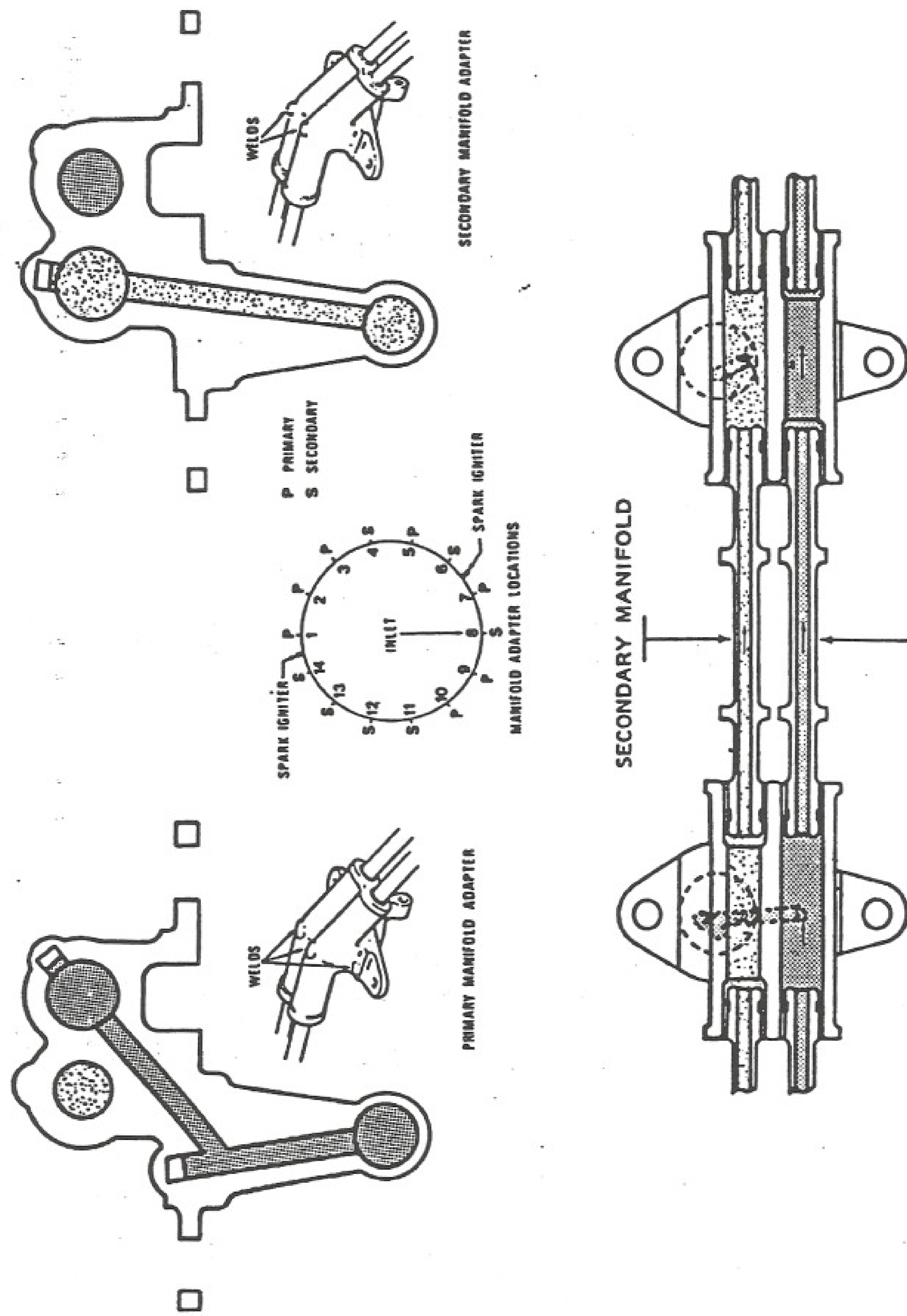
TO PRIMARY AND SECONDARY MANIFOLD POSITION
30 – 35% N-1



FUEL FLOW DIVIDER

The fuel flow divider is located on the gas generator case and directs metered fuel to the fuel nozzles. During the start cycle, fuel is directed only to the primary nozzles and then as N_1 speed increases, fuel is directed to all nozzles. When the engine is not operating, the flow divider serves as a dump valve, allowing the manifold to drain overboard.

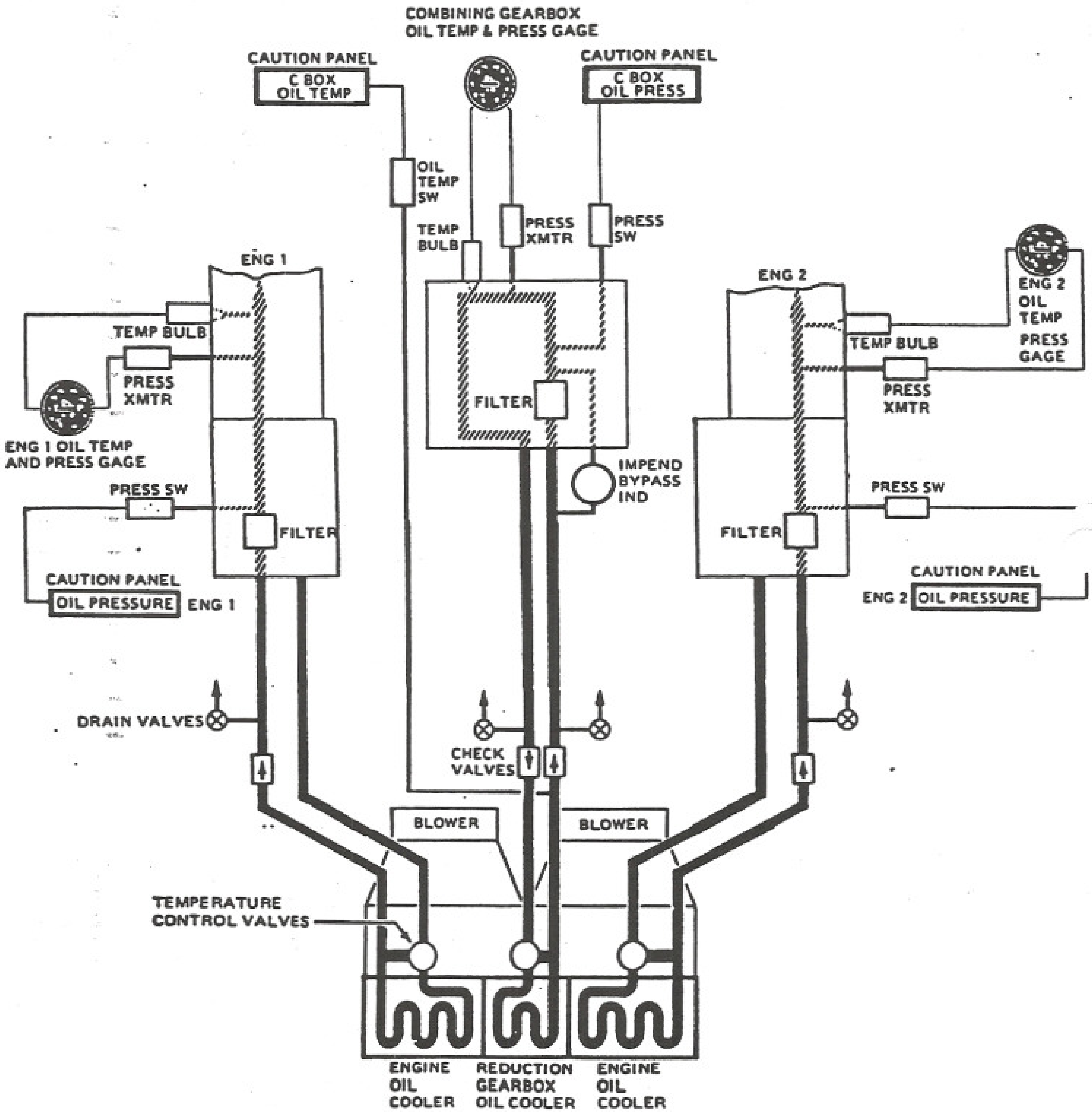
FUEL MANIFOLD SCHEMATIC



FUEL MANIFOLD

The 14 fuel nozzles, 7 primary, 7 secondary are connected by tubes to form a dual manifold around the gas generator case. The primary nozzles are located for the best spray pattern for starting and are supplied fuel through the forward manifold tubes.

ENGINE OIL SYSTEM SCHEMATIC



ENGINE OIL SYSTEM

The powerplant has three separate lubrication systems; identical systems provide lubrication for the two power sections, accessory gearbox sections and their respective input sections of the reduction gearbox. A third oil system provides lubrication for the output section of the reduction gearbox.

Individual oil coolers are provided aft of the powerplant for each system, with two blowers driven by the reduction gear train of each power section.

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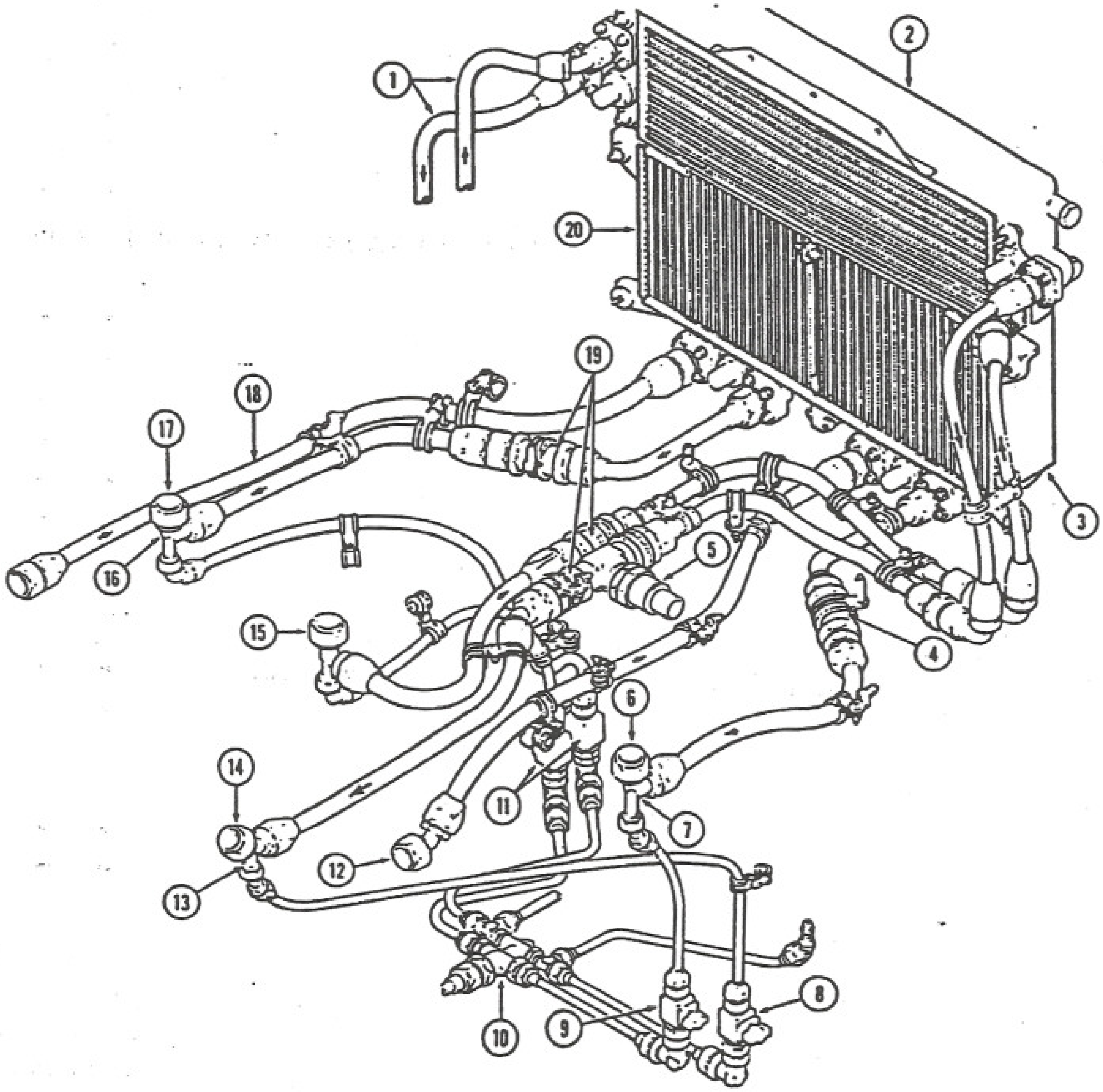
OIL COOLERS AND LINES



1. Transmission oil lines
2. Reduction gearbox and transmission oil cooler
3. Left power section oil cooler
4. Check valve
5. Oil temperature switch
6. Left power section oil inlet line
7. Direct reading gage attachment point
8. Drain valve
9. Drain valve
10. Drain manifold
11. Drain valves
12. Left power section oil outlet line
13. Direct reading gage attachment point
14. Reduction gearbox oil inlet line
15. Reduction gearbox oil outlet line
16. Direct reading gage attachment point
17. Right power section oil inlet line
18. Right power section oil outlet line
19. Check valves
20. Right power section oil cooler

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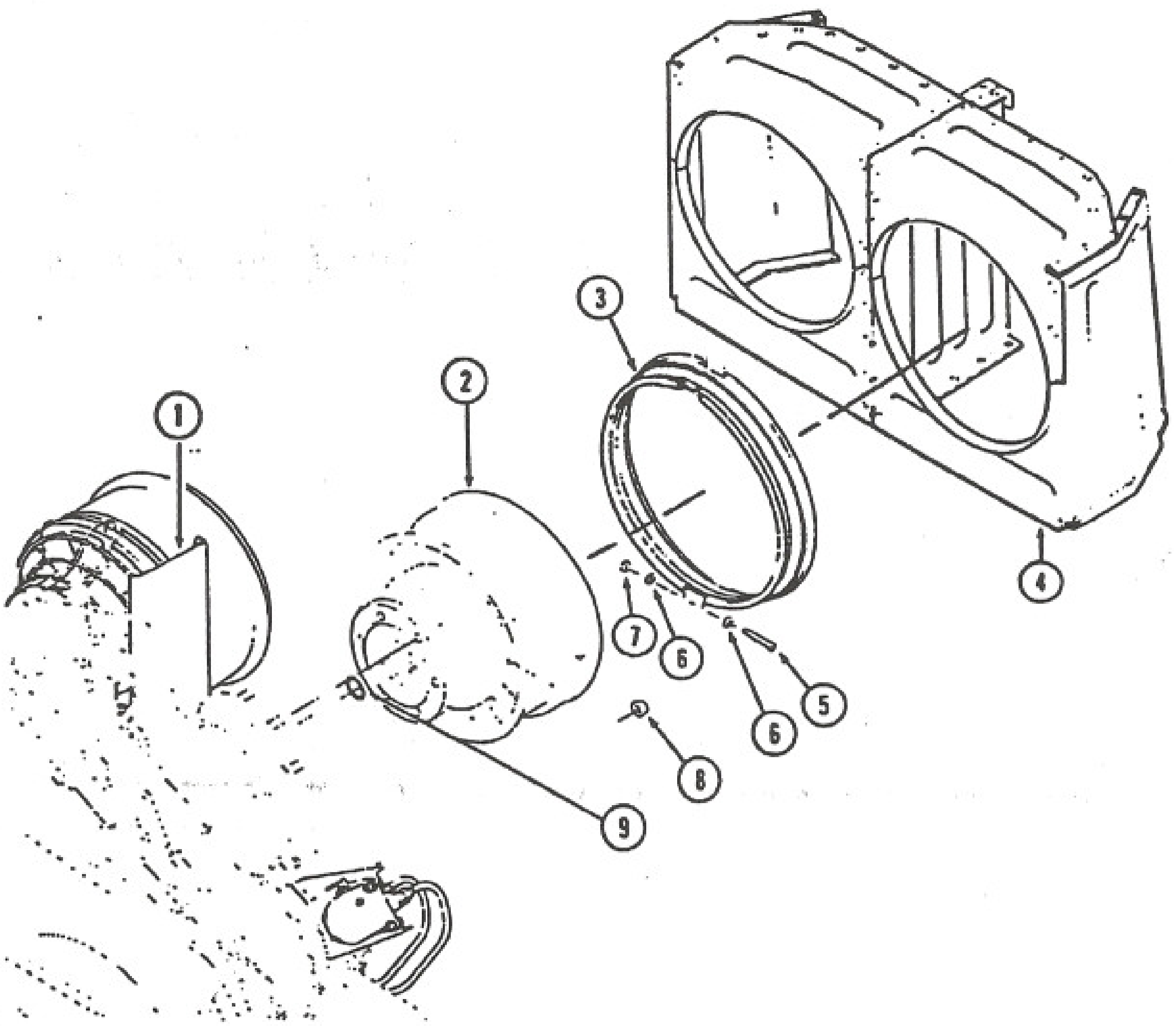
OIL COOLERS

The three powerplant oil systems are connected by external lines to three oil coolers located aft of the powerplant. The upper cooler is a dual unit with separate isolated sections for the reduction gearbox and transmission systems. The reduction gearbox is connected to the left side and uses the lower 60% of the upper cooler. Separate coolers are provided for each of the power sections. The reduction gearbox oil temperature switch is located in a line from the cooler.

Bell

OIL COOLER BLOWERS

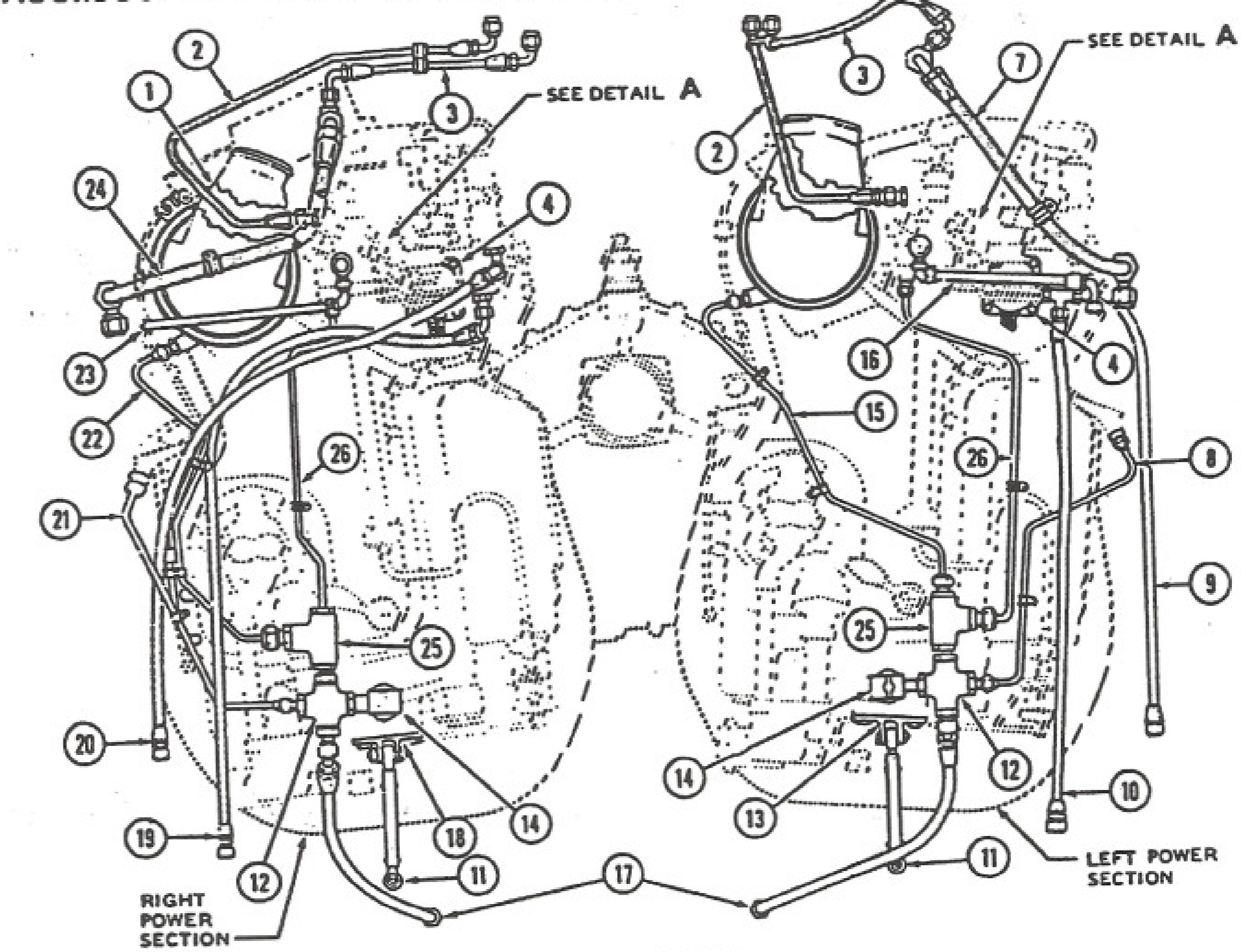


1. Shield
2. Oil cooler blower
3. Boot
4. Oil cooler duct
5. Screw
6. Washer (AN960C10L)
7. Nut
8. Nut
9. Packing

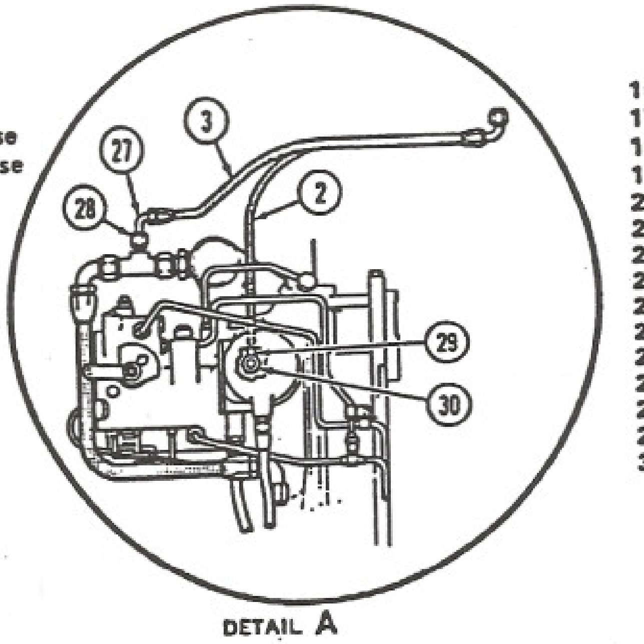
OIL COOLER BLOWERS

Two oil cooler blowers are mounted to and driven by the reduction gearbox. Each blower circulates air through one half of the cooler installation when the respective power section is operating.

ACCESSORY GEARBOX COMPONENTS



1. Starter-generator
2. Low fuel pressure sensing hose
3. High fuel pressure sensing hose
4. Tachometer generator
5. Deleted
6. Deleted
7. Fuel inlet hose
8. Scupper drain
9. Fuel filter drain hose
10. Fuel pump seal drain
11. Tube assembly
12. Cross fitting
13. Mount fitting
14. Oil drain valve
15. Seal drain



DETAIL A

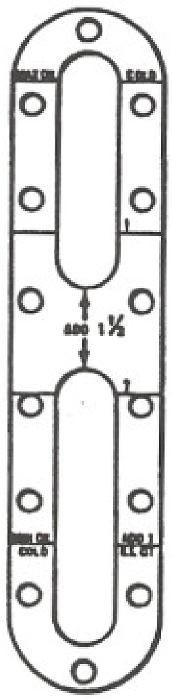
16. Governor bleed hose
17. Oil tank drain hose
18. Mount fitting
19. Fuel pump seal drain
20. Fuel filter drain hose
21. Scupper drain
22. Seal drain
23. Governor bleed hose
24. Fuel inlet hose
25. Tee fittings
26. Seal drains
27. Elbow
28. Nut
29. Elbow
30. Union

ACCESSORY GEARBOX COMPONENTS

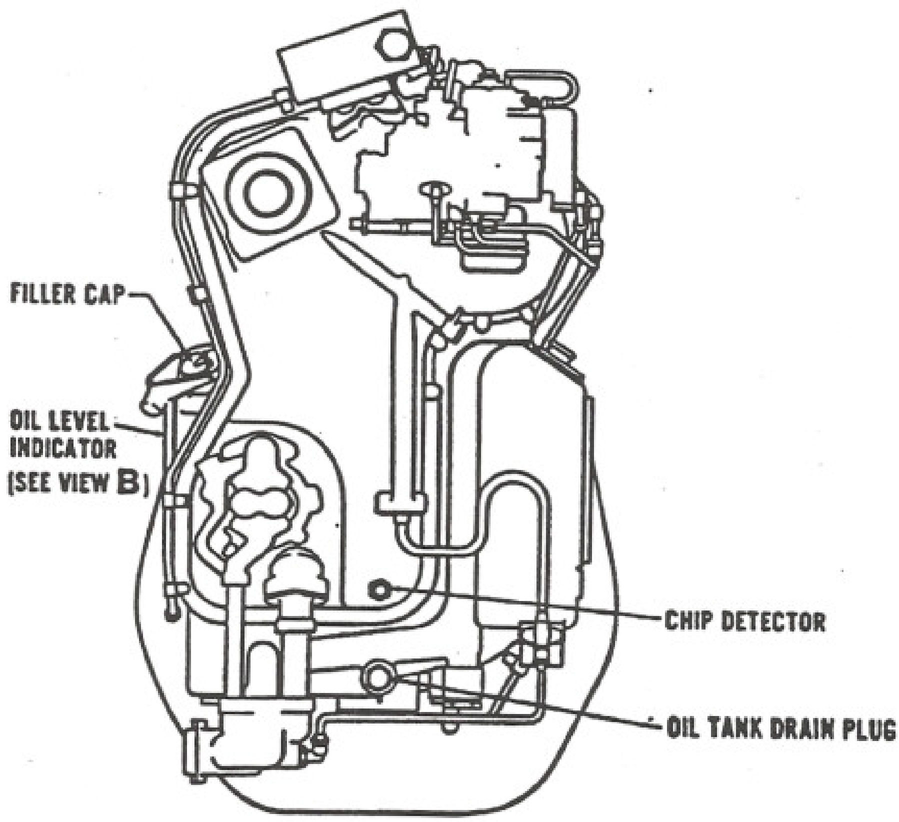
Components installed on the accessory gearboxes include accessories, fuel hoses, an oil drain valve, oil drain hoses and lines, and engine mount fitting.

The oil filler cap and oil level sight gages may be installed on either side of the accessory gearbox to position them outboard when a power section is installed.

ACCESSORY GEARBOX SERVICING AND CHIP DETECTOR



VIEW B
ACCESSORY GEARBOX
OIL LEVEL INDICATOR



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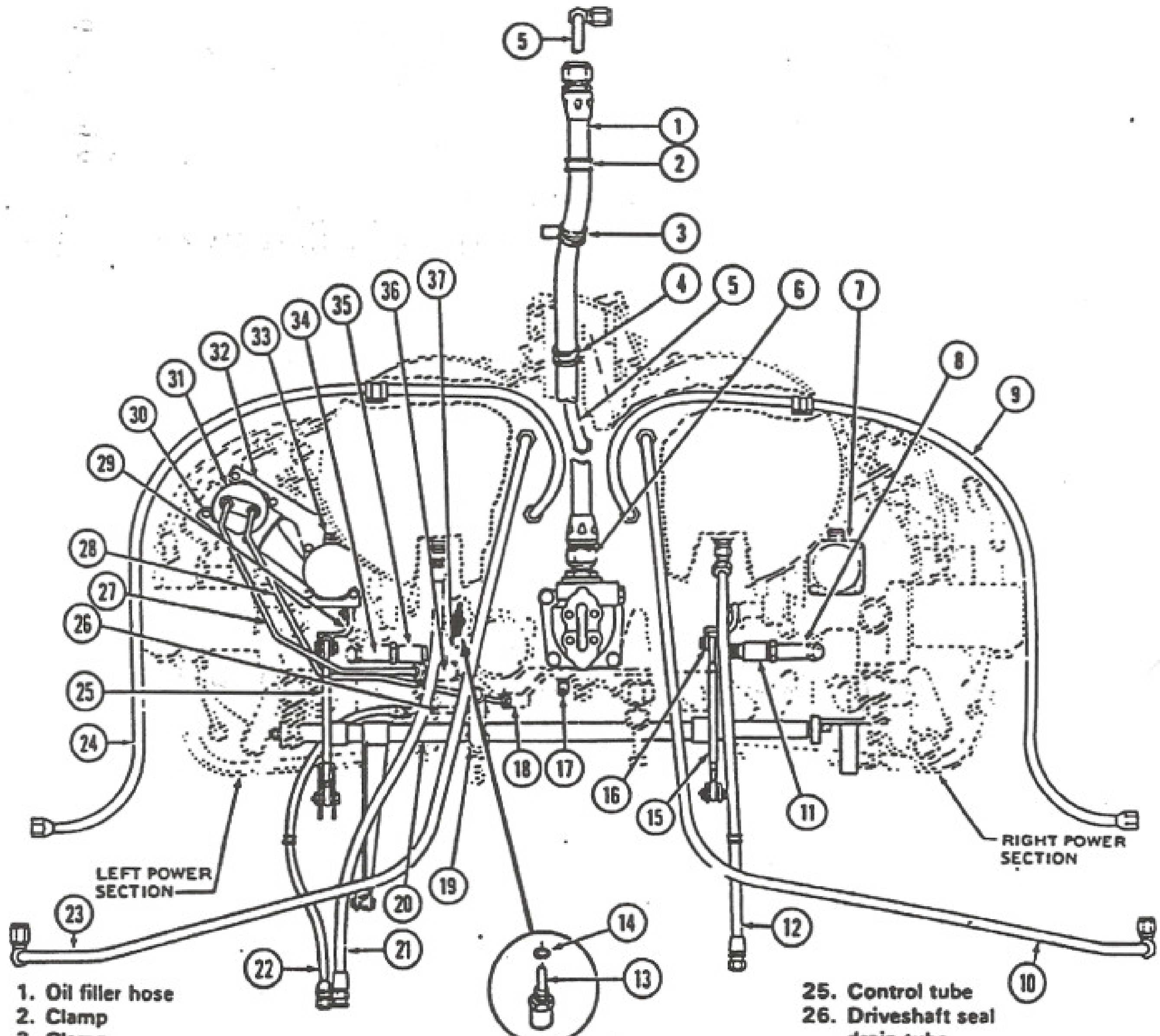
REDUCTION GEARBOX COMPONENTS



1. Oil filler hose
2. Clamp
3. Clamp
4. Clamp
5. Vent hose
6. Oil filler valve
7. Tachometer generator
8. Oil pressure port fitting
9. Torquemeter pressure transmitter hose (pressure)
10. Torquemeter pressure transmitter hose (vent)
11. Oil pressure switch
12. Blower seal drain hose
13. Oil temperature bulb
14. Packing
15. Control tube
16. Lever
17. Bracket
18. 90 degree oil pressure switch elbow
19. 45 degree oil inlet elbow
20. Droop compensator jackshaft
21. Blower seal drain hose
22. Driveshaft seal drain hose
23. Torquemeter pressure transmitter hose (vent)
24. Torquemeter pressure transmitter hose (pressure)
25. Control tube
26. Driveshaft seal drain tube
27. Tube assembly
28. Tube assembly
29. Lever
30. Lower bracket
31. Reduction gearbox filter bypass indicator
32. Upper bracket
33. Tachometer generator
34. Oil pressure port fitting
35. Oil pressure switch
36. Tee fitting
37. Oil pressure switch

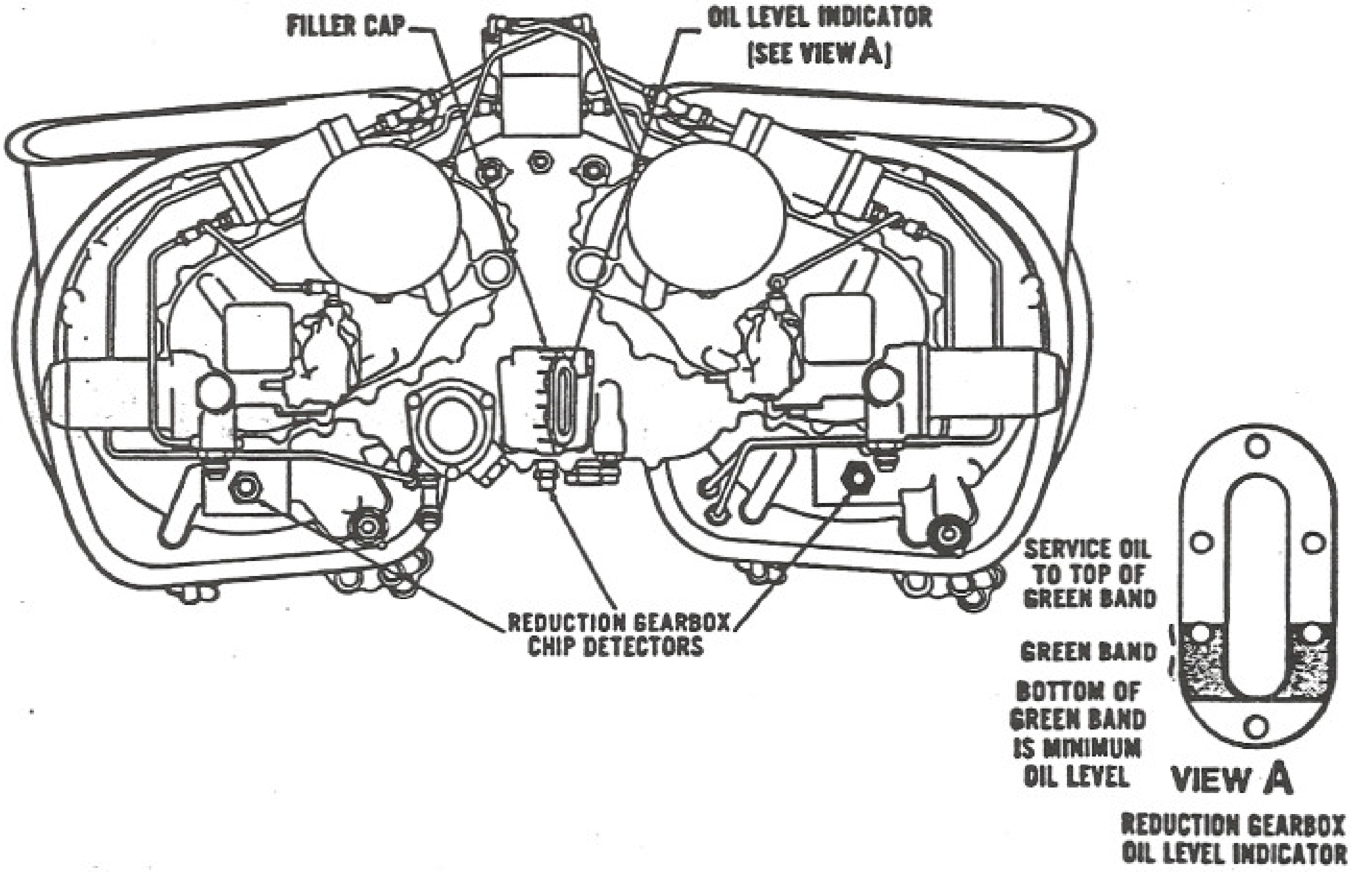
412062-22

REDUCTION GEARBOX COMPONENTS

Components installed to the reduction gearbox includes accessories, N_2 control jackshaft, engine mount bearings, oil system components and hoses.

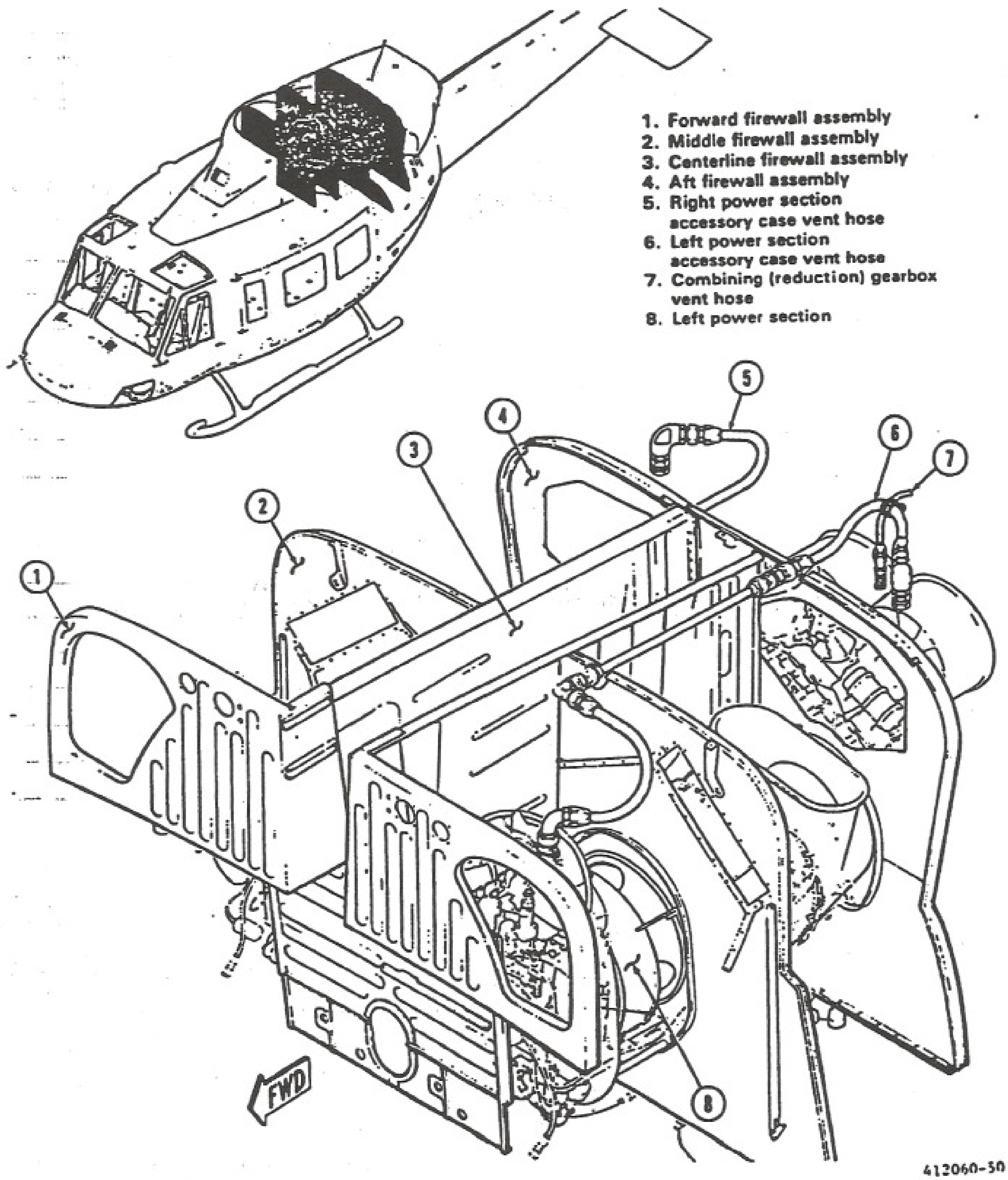
The oil level sight gage is located at the gearbox's lower center and is viewed from the right side. The gearbox is serviced through a filler hose extending up to a filler adapter on the gearbox top cowling.

REDUCTION GEARBOX SERVICING AND CHIP DETECTOR



Bell

FIREWALL INSTALLATION



1. Forward firewall assembly
2. Middle firewall assembly
3. Centerline firewall assembly
4. Aft firewall assembly
5. Right power section accessory case vent hose
6. Left power section accessory case vent hose
7. Combining (reduction) gearbox vent hose
8. Left power section

412060-30

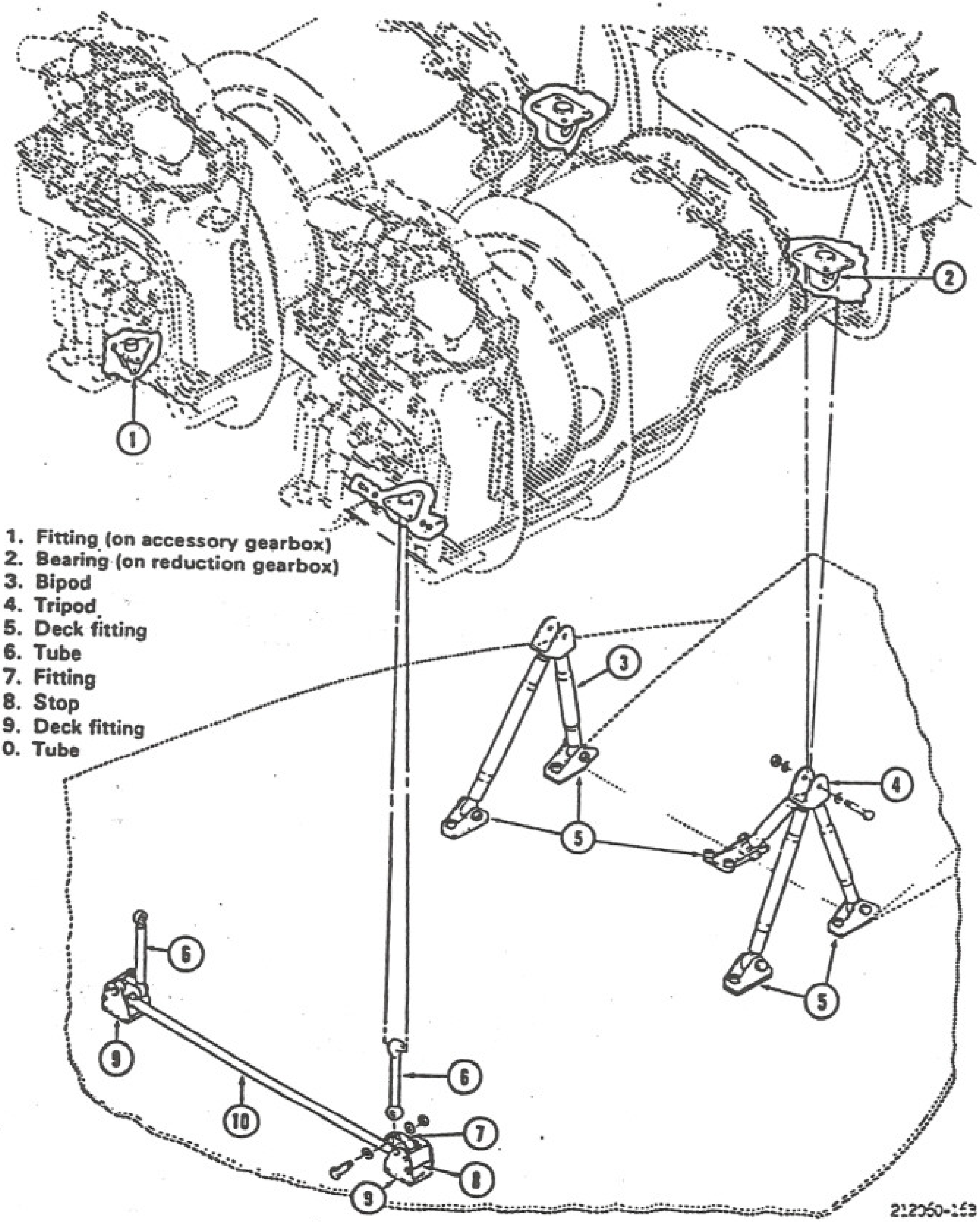
See TB 412-90-89 for inspection of mid firewall blind rivets.

FIREWALL INSTALLATION

The firewall installation consists of the forward, middle, centerline and aft firewalls. This installation isolates the two power sections, reduction gearbox area, drive shaft tunnels, and each power section gas generator and power turbine/exhaust sections.

Bell

ENGINE MOUNTS

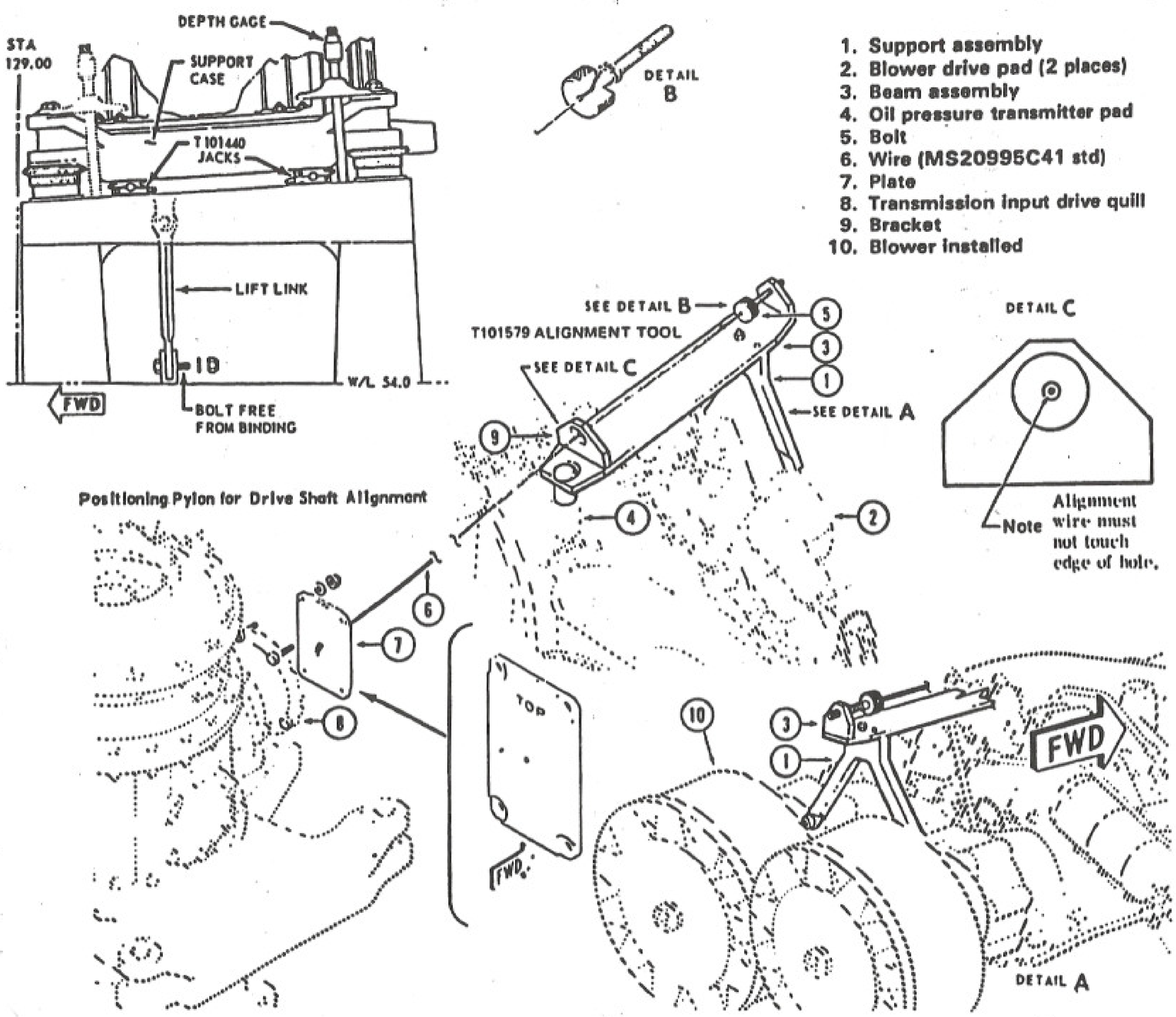


1. Fitting (on accessory gearbox)
2. Bearing (on reduction gearbox)
3. Bipod
4. Tripod
5. Deck fitting
6. Tube
7. Fitting
8. Stop
9. Deck fitting
10. Tube

ENGINE MOUNTS

The reduction gearbox is supported by a tripod on the left and a bipod on the right. Each accessory gearbox is supported by a vertical tube interconnected through bellcrank fittings by a horizontal tube. Shims located between deck fittings and the engine deck align the engine to the transmission.

Bell



Positioning Pylon for Drive Shaft Alignment

1. Support assembly
2. Blower drive pad (2 places)
3. Beam assembly
4. Oil pressure transmitter pad
5. Bolt
6. Wire (MS20995C41 std)
7. Plate
8. Transmission input drive quill
9. Bracket
10. Blower installed

POWERPLANT TO TRANSMISSION ALIGNMENT CHECK

A check of the powerplant to transmission alignment is required when any of the following conditions exist:

a. Main driveshaft coupling splines show excessive wear.

b. Indication of main driveshaft couplings overheating.

c. Replacement of the transmission isolation mounts.

d. Hard landing.

e. Replacement of engine mounts.

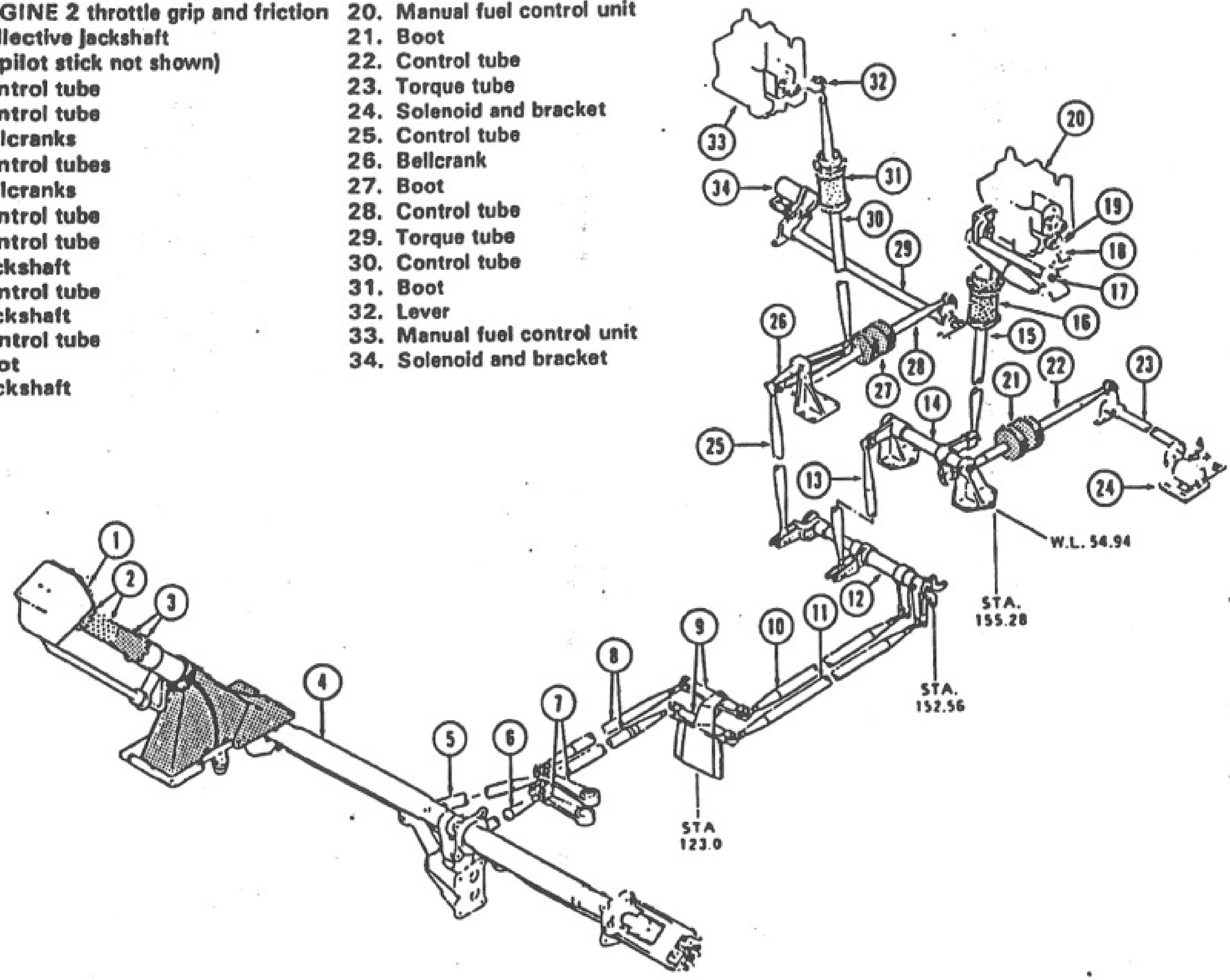
f. Major repair or replacement of components is required in center fuselage, tail boom or pylon support structure.

g. Main driveshaft misalignment is suspected for any reason.

Alignment check is not required after engine replacement, provided the engine mount and/or shim stack-up is not changed.

Bell

1. IDLE STOP REL switch
2. ENGINE 1 throttle grip and friction
3. ENGINE 2 throttle grip and friction
4. Collective jackshaft (copilot stick not shown)
5. Control tube
6. Control tube
7. Bellcranks
8. Control tubes
9. Bellcranks
10. Control tube
11. Control tube
12. Jackshaft
13. Control tube
14. Jackshaft
15. Control tube
16. Boot
17. Jackshaft
18. Link
19. Lever
20. Manual fuel control unit
21. Boot
22. Control tube
23. Torque tube
24. Solenoid and bracket
25. Control tube
26. Bellcrank
27. Boot
28. Control tube
29. Torque tube
30. Control tube
31. Boot
32. Lever
33. Manual fuel control unit
34. Solenoid and bracket

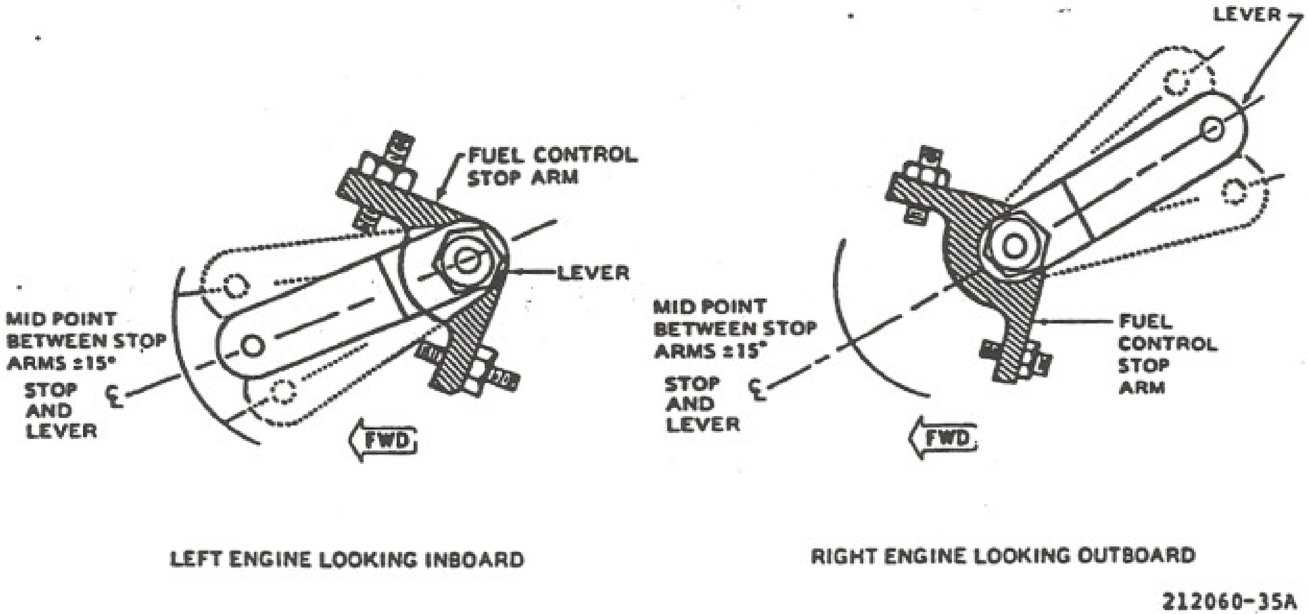


POWER LEVER CONTROL SYSTEM (N-1)

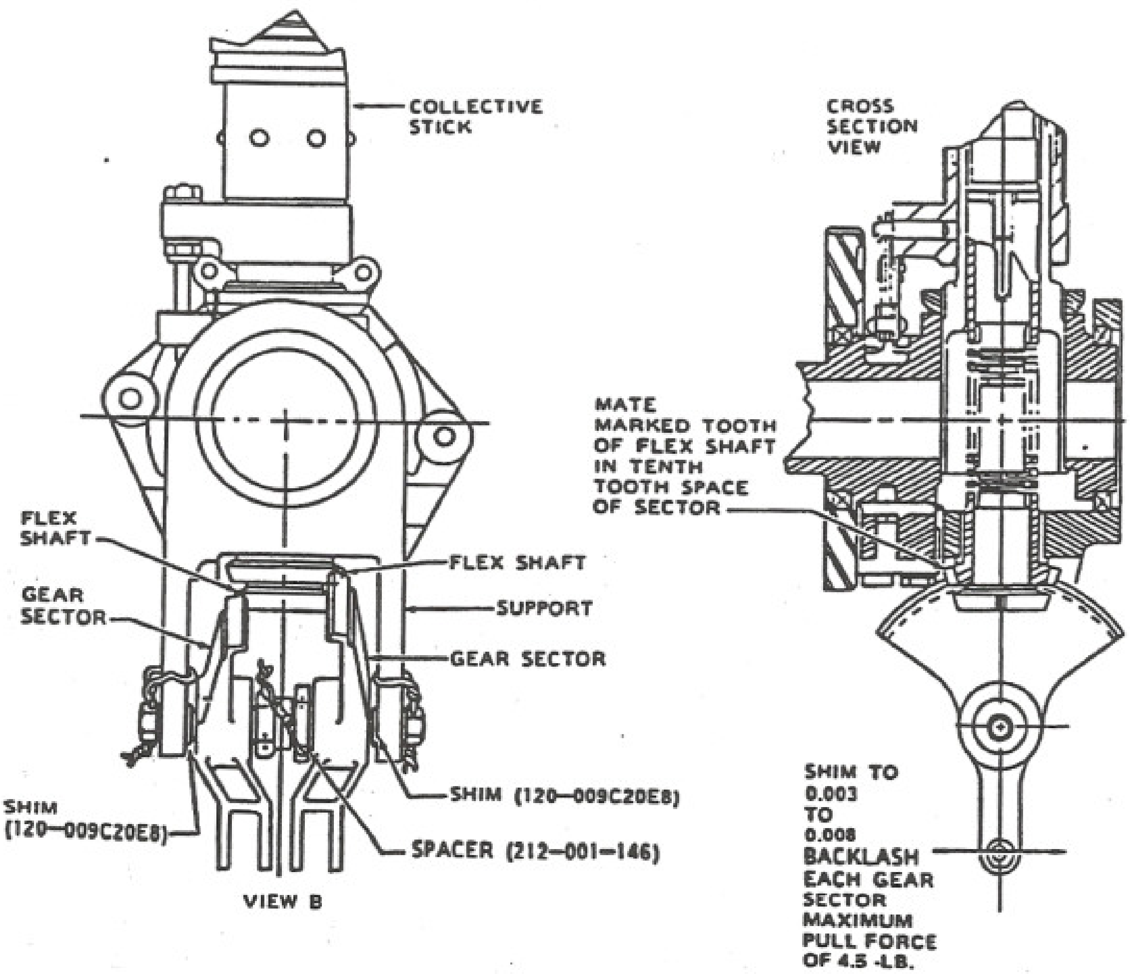
The power lever controls system consist of two parallel mechanical linkages connecting the dual control twist grips of the collective stick to the manual fuel control units. The linkage extends down through the collective stick to sector gears, inboard to the center, then aft under the cabin floor into the pylon island, then up to the manual fuel control on each accessory gearbox. The upper twist grip is the Engine No. 1 control, the lower is Engine No. 2 control. A flight idle stop is located in each system to prevent inadvertant shut-down of a power section when retarding a twist grip.

Bell

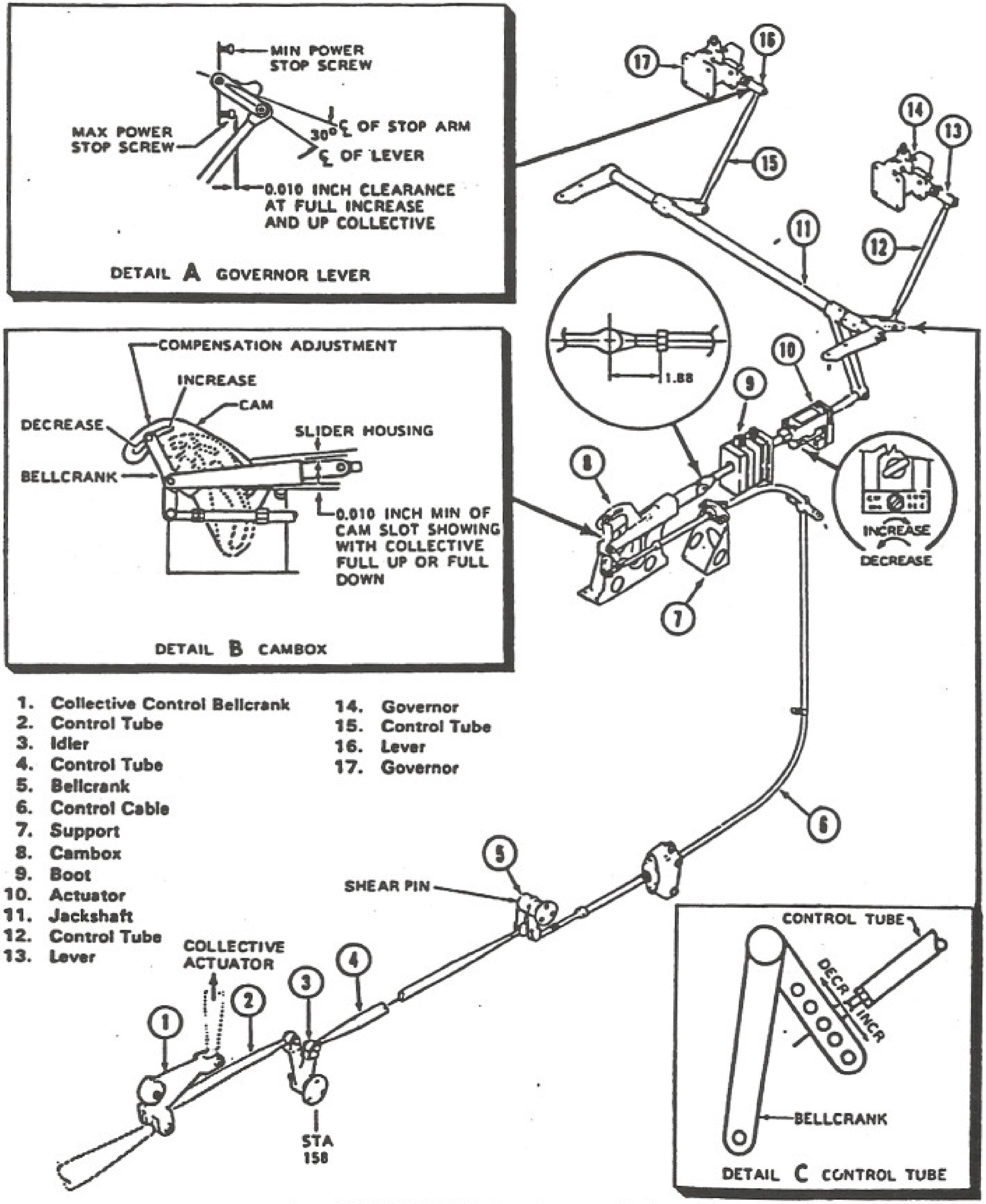
LOCATION OF LEVERS ON MANUAL FUEL CONTROLS



THROTTLE CONTROL GEAR SECTORS SHIMMING AND BACKLASH



N-2 CONTROL SYSTEM



1. Collective Control Bellcrank
2. Control Tube
3. Idler
4. Control Tube
5. Bellcrank
6. Control Cable
7. Support
8. Cambox
9. Boot
10. Actuator
11. Jackshaft
12. Control Tube
13. Lever
14. Governor
15. Control Tube
16. Lever
17. Governor

See TB 412-90-87 for improved clamping arrangement for droop compensator cable.

DROOP COMPENSATOR CONTROL SYSTEM (N-2)

The droop compensator control system consists of a mechanical input from the collective pitch control, through a droop compensator cam assembly, an electrical linear actuator, a jackshaft and control tubes to the power turbine governors. The droop compensator cam maintains and stabilizes the pre-selected N-2 RPM by changing governor control as collective pitch is increased or decreased. The linear actuator provides for N-2 RPM selection by repositioning the lever on both power turbine governors.

PT6T-3 TWIN POWER SECTION TURBOSHAFT ENGINE

DESCRIPTIVE NOTES

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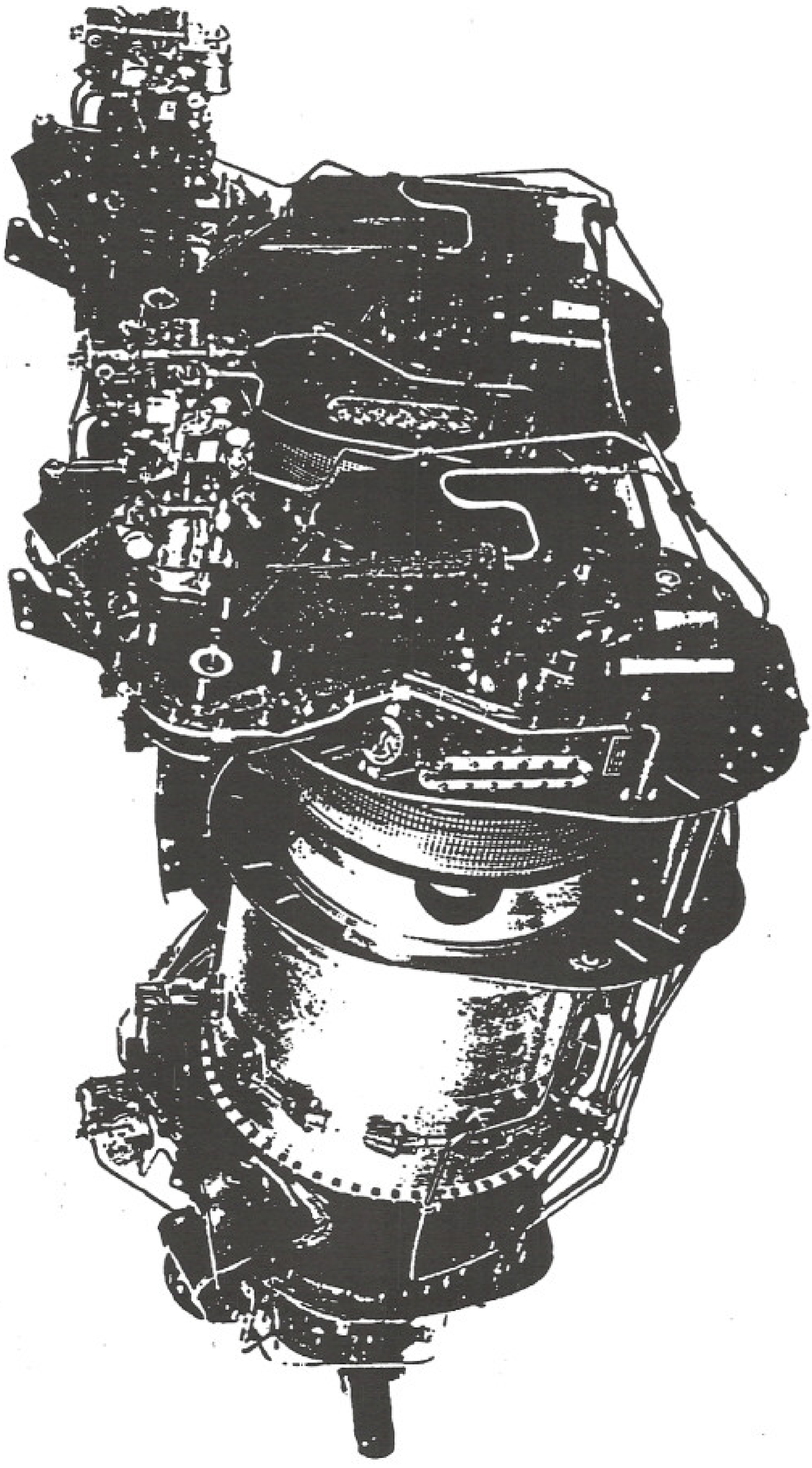
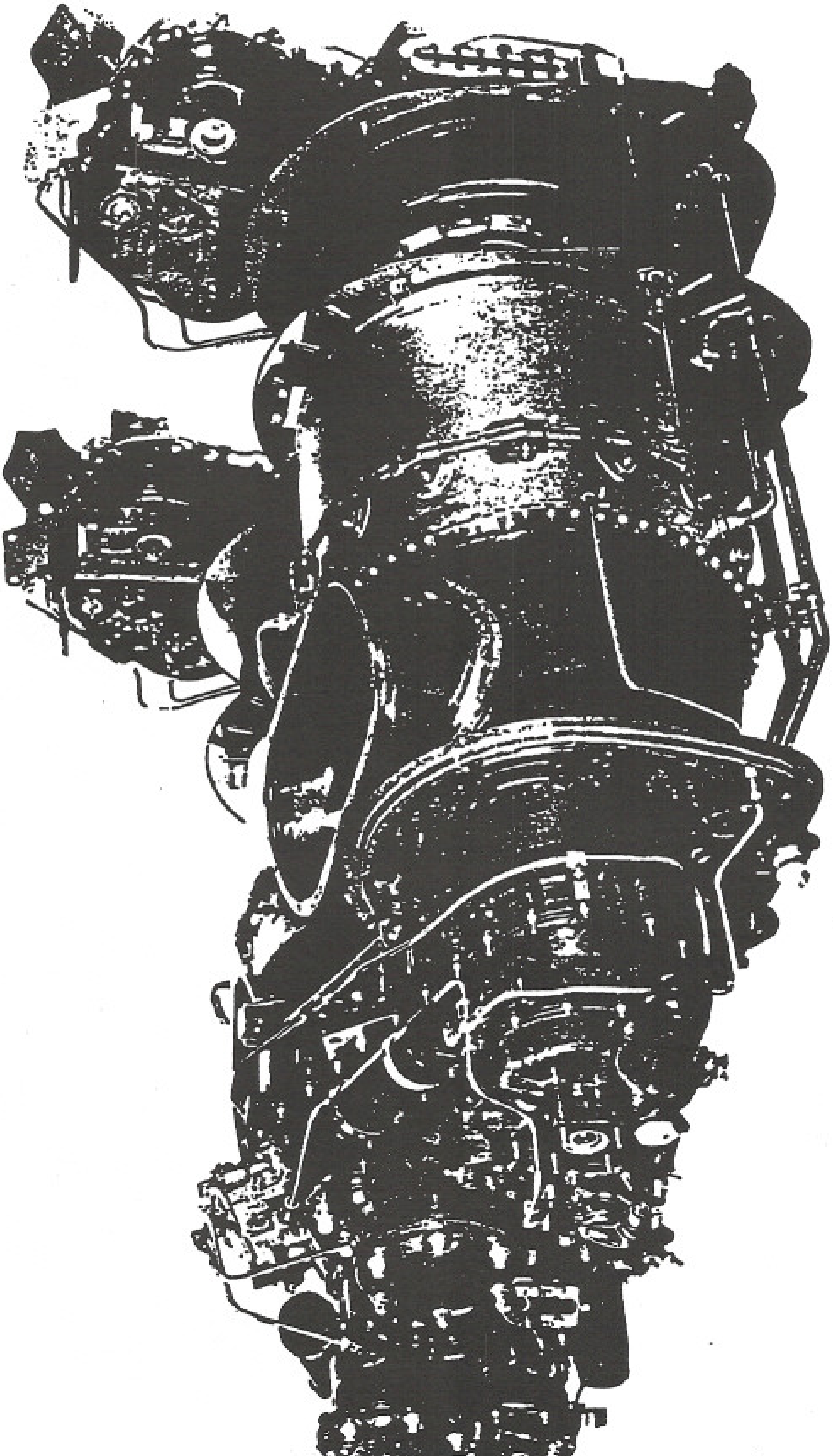
PART NO. 3018840

REISSUED 30 SEPTEMBER 1978

PRATT & WHITNEY AIRCRAFT OF CANADA LTD.
BOX 10, LONGUEUIL, QUEBEC, CANADA J4K 4X9





Right Hand Rear View

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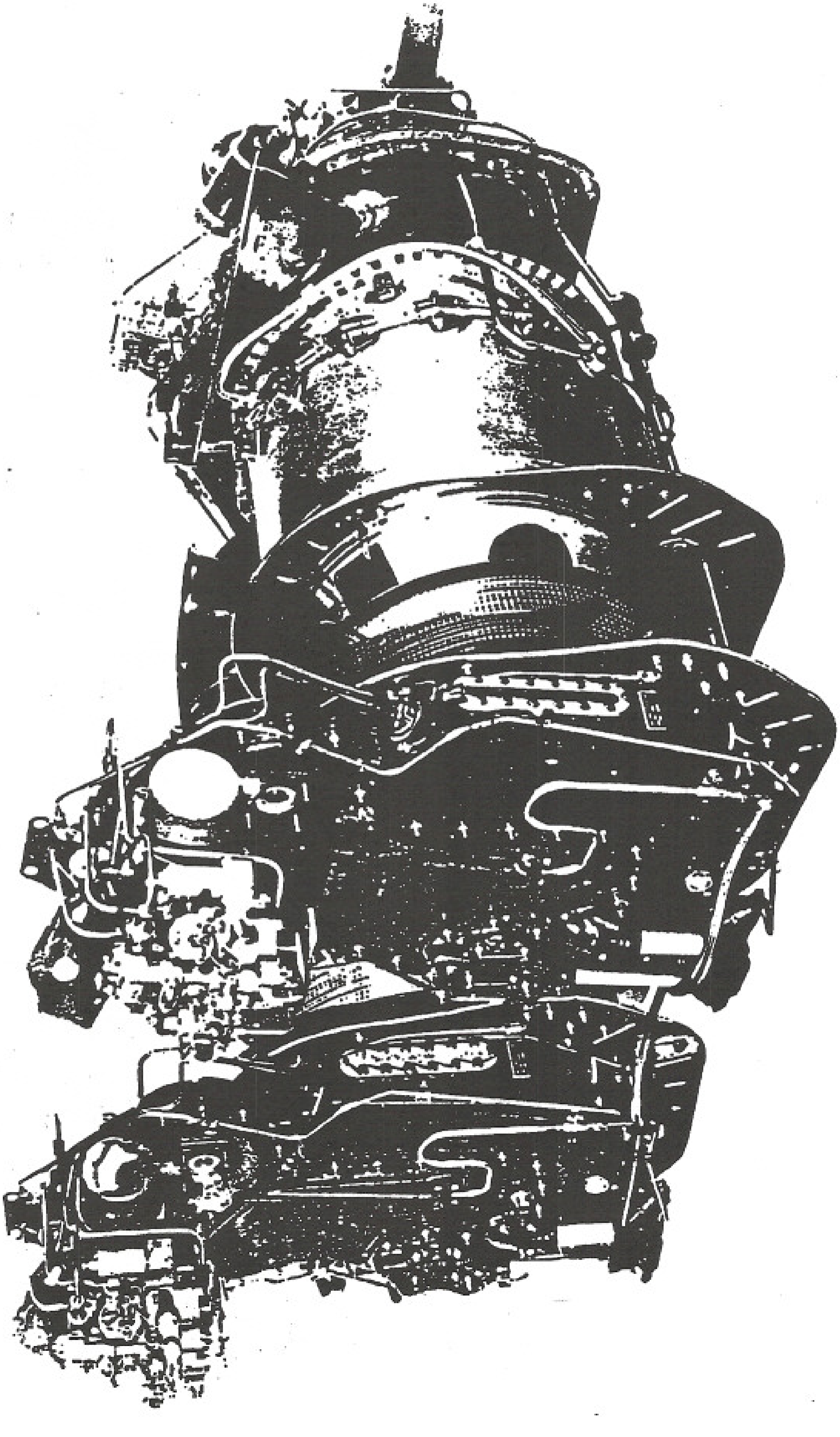

Left Hand I ew

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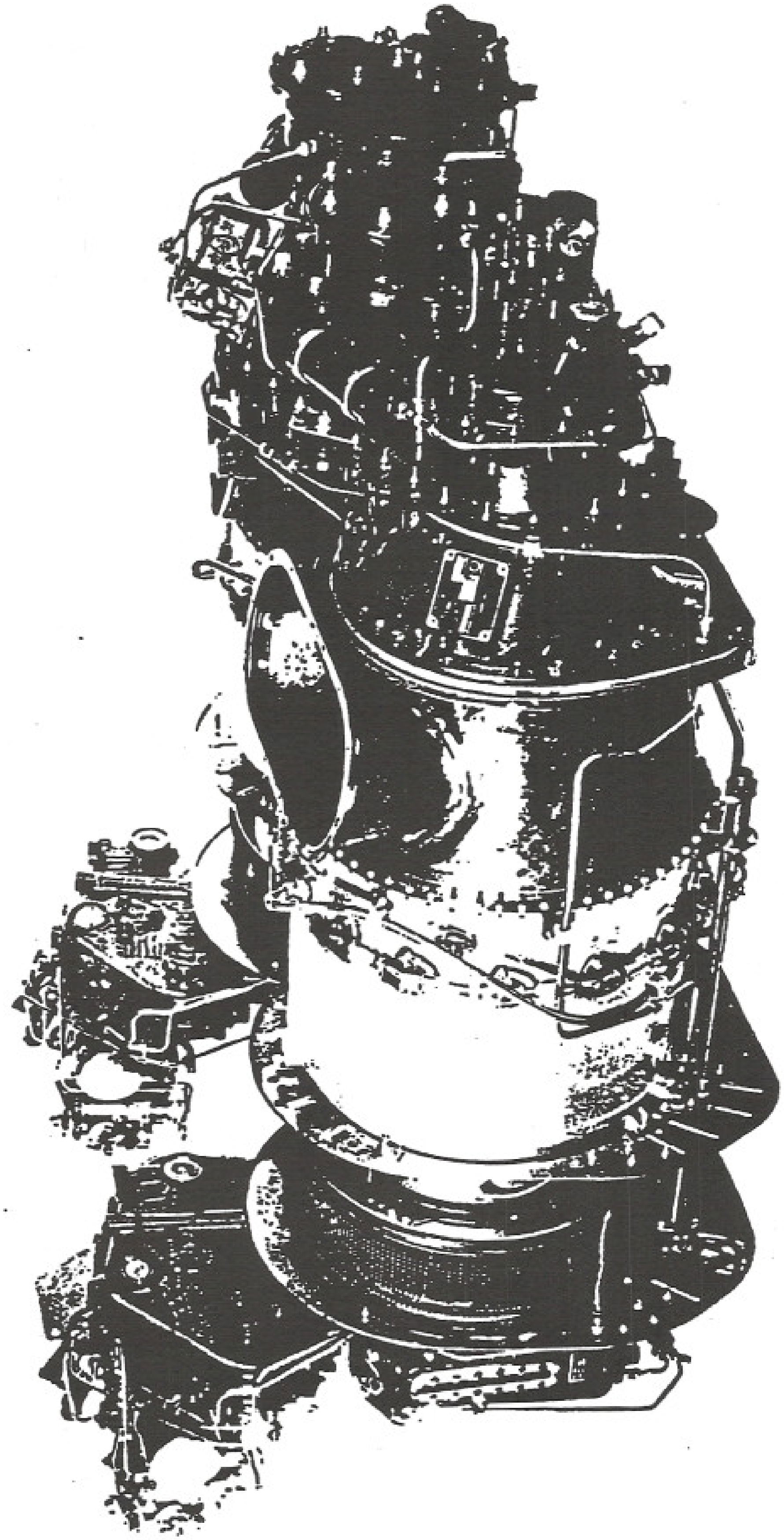
United Aircraft of Canada Limited



Left Hand Rear View

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PART 1

GENERAL INFORMATION AND DESCRIPTION

SECTION 1

INTRODUCTION

The following notes describe the PT6T-3 Twin Pac™ engine and its operating principles. For a comprehensive description of gas turbine engine fundamentals, the reader is referred to 'The Aircraft Gas Turbine Engine and its Operation', PWA Operating Instructions 200.

Notes and illustrations herein are prepared for the basic engine and are generally applicable to the current model. However, since these engines are undergoing continuous improvements in design and manufacture, it is anticipated that the appearance of parts may change as refinements are introduced.

Design changes introduced too late for inclusion in these notes will be included in subsequent issues.

For approved directional, positional and basic terminology refer to Figure 1-1-1. The No. 1 Power Section is defined as the Section of the engine on the left when the engine is viewed from the reduction gearbox end, facing towards the accessory gearbox. Terminology used is described as follows:

Twin-Pac engine - Reduction gearbox and two power sections.

Power Section - Accessory gearbox, gas generator assembly, power turbine and exhaust assembly.

Reduction Gearbox - Reduction input gearbox section for each power section plus the output section

Terms such as clockwise, counter-clockwise right and left, apply as from the same view point.

The following is a list of abbreviations used in these notes.

FCU	Fuel Control Unit
AFCU	Automatic Fuel Control Unit
MFCU	Manual Fuel Control Unit
N_f	Power Turbine Rotational Speed
N_g	Compressor Turbine Rotational Speed
N_s	Output Shaft Rotational Speed
P_o	By-pass Fuel Pressure
P_1	Fuel Pump Outlet Pressure
P_2	Metered Fuel Pressure
P_3	Diffuser Pipes Outlet Air Pressure
$P_{2.5}$	Compressor Interstage Air Pressure
P_a	Ambient Air Pressure
P_g	Pneumatic Pressure to N_f Governor and TCU
P_r	Regulated Pneumatic Pressure (Source of P_g)
P_x	Pneumatic Pressure Controlled by Enrighment Valve
P_y	Pneumatic Pressure Controlled by Governor Valve
T_{t5}	Inter-turbine Temperature
TCU	Torque Control Unit

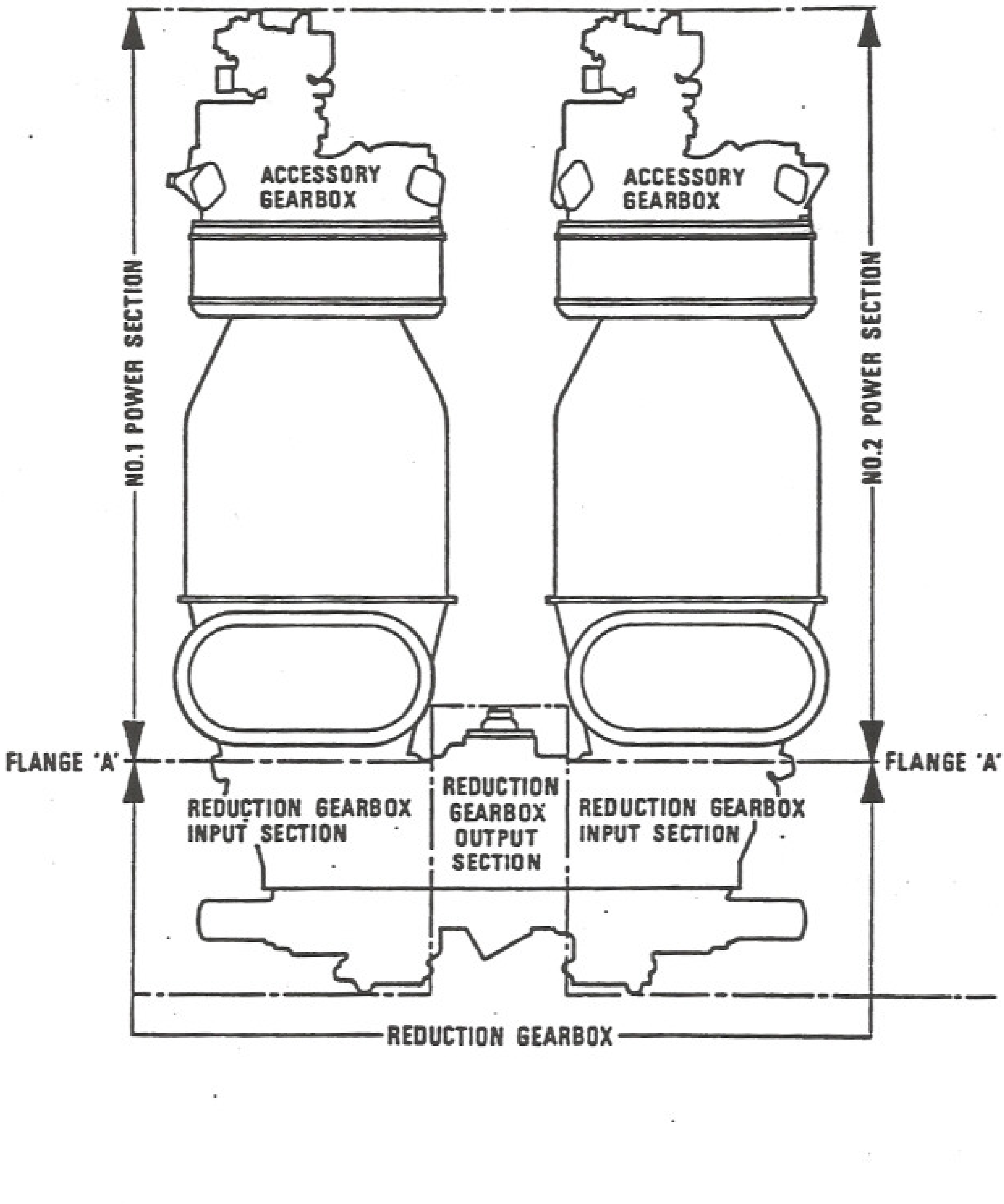


Figure 1-1-1 PT6T-3 Twinned Turboshaft Engine Assemblies Designation

SECTION 2

LEADING PARTICULARS AND SPECIFICATIONS

GENERAL

1 Leading particulars of the PT6T-3 Twinned Turboshaft Engine are as follows: (Refer to Table 1-2-1.)

RATING	OUTPUT SHAFT SPEED (Ns) RPM	MINIMUM SHP		MAXIMUM SFC lbs/shp/hr.	
		TWIN	SINGLE	TWIN	SINGLE
Take-off	6,600	1,800	900	0.595	0.603
Maximum Continuous	6,600	1,600	800	0.599	0.609
Cruise 'A' Rating	6,600	1,250	625	0.628	0.640
Cruise 'B' Rating	6,600	1,100	550	0.653	0.667

NOTE

Standard day, sea level, static conditions with no installation losses and no air bleed or airframe accessory power absorption.

Type	Twin Power Section - Free Turbine Turboshaft
Type of Combustion Chamber	Annular
Engine Dimensions, Basic at Room Temperature:	
Length	65.75 inches (1670 mm)
Width	43.47 inches (1104 mm)
Height	32.61 inches (828 mm)
Output Shaft:	
Rotation (Looking Forward)	Clockwise
Configuration	Externally Splined
Gear Ratio (to Free Turbine)	1:5
Compressor Pressure Ratio	7:1
Maximum Total Oil Consumption	0.4 lb./hr. (0.18 Kg./hr.) measured over a 10-hour period
Specification Weight - Dry	635 lbs. (288 Kg.)
Weight of Additional Equipment - Dry	36.3 lbs. (16.47 Kg.)
Weight of Oil to Wet Engine and Fill Tank - approx.	37.3 lbs. (16.91 Kg.)
Total Weight - approx.	708.6 lbs. (321.4 Kg.)

Table 1-2-1 PT6T-3 Engine Specifications

2 Leading particulars of the PT6T-3 engine accessory and reduction gearbox drives are as follows: (Refer to Table 1-2-2.)

ACCESSORY GEARBOX DRIVES 100% N_g = 38,100 RPM		
	Rotation	Speed Ratio
1 Starter-Generator	C	0.2911
2 Tachometer-Generator (N_g)	C	0.1103
REDUCTION GEARBOX DRIVES MAX. N_f = 33,000 RPM		
3 Tachometer-Generator (N_f)	CC	0.1279
4 Blower Drive	C	0.2435

Table 1-2-2 PT6T-3 Engine Accessory and Reduction Gearbox Drives - Leading Particulars

3 The PT6T-3 engine fuel and lubrication system specifications are as follows: (Refer to Table 1-2-3.)

Fuel Specification	PWA522, CPW46. Aviation Gasoline MIL-G-5572 (for a maximum of 150 hours between overhauls if PWA522 is not available). Refer to Engine Service Bulletin No. 5144 for approved engine fuels.
Oil Specification	PWA521. Refer to Engine Service Bulletin No. 5001 for approved oils.
Accessory Gearbox Oil Tank Capacity	1.60 U.S. Gallons (1.33 Imp. gallons or 6.05 liters)
Usable Quantity	0.75 U.S. Gallon (0.62 Imp. gallons or 2.83 liters)
Reduction Gearbox Oil Tank Capacity	1.25 U.S. Gallons (1.04 Imp. gallons or 4.73 liters)
Usable Quantity	0.25 U.S. Gallon (0.21 Imp. gallons or 0.95 liter)

Table 1-2-3 Fuel and Lubrication Systems - Specifications

4 The engine, power section and reduction gearbox shipping container leading particulars are as follows: (Refer to Tables 1-2-4, 1-2-5 and 1-2-6.)

Length	80 inches (2032 mm)
Width	64 inches (1626 mm)
Height	57 inches (1448 mm)
Weight - approximate	750 lbs. (340.2 Kg.)

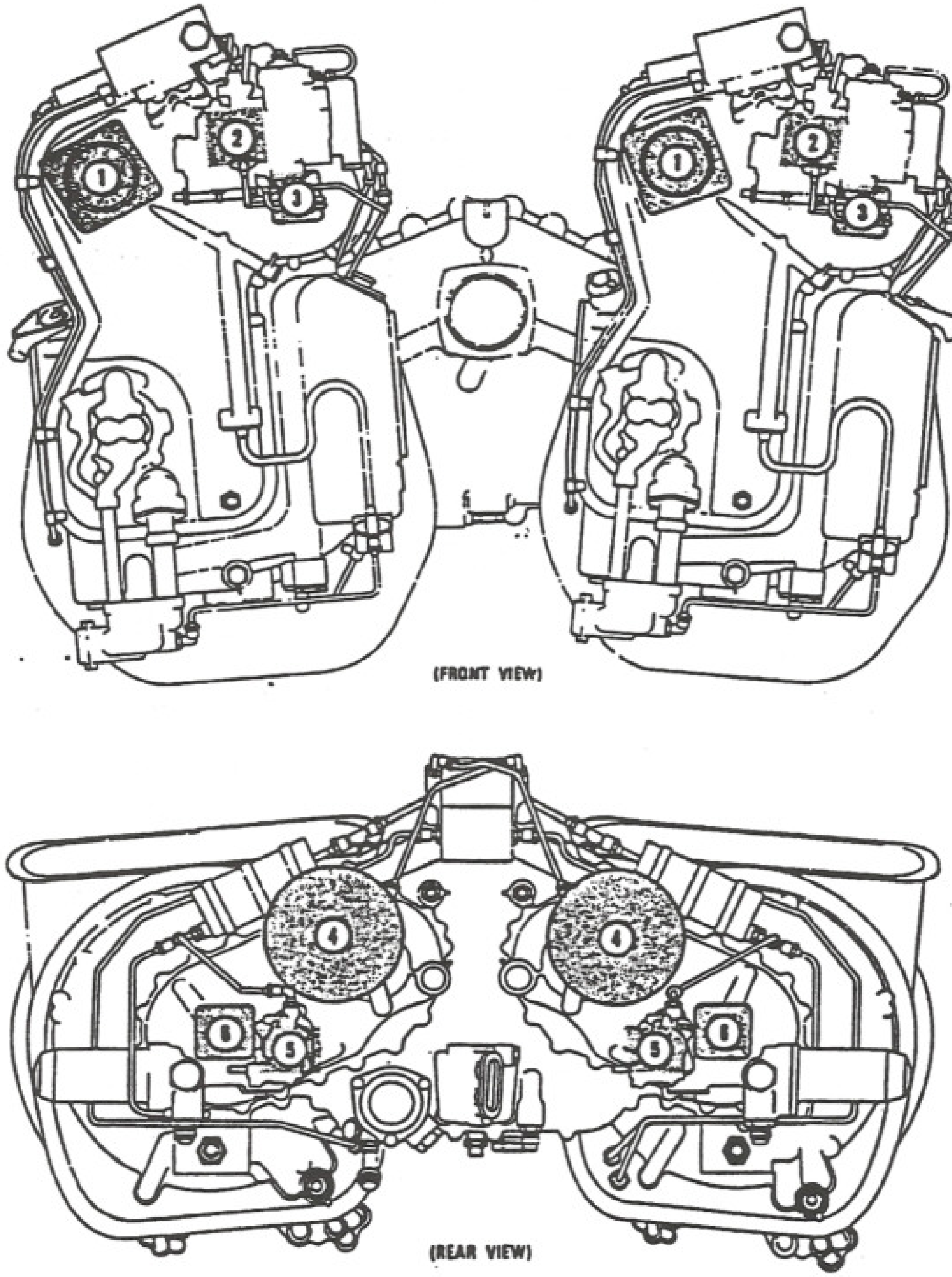
Table 1-2-4 Engine Fiberboard Shipping Container - Leading Particulars

	Metal (Reusable)	Fiberboard (Non-reusable)
Length	69 inches (1752 mm)	63 inches (1600 mm)
Width	34 inches (864 mm)	32 inches (814 mm)
Height	49 inches (1245 mm)	45 inches (1144 mm)
Weight - approximate	631 lbs (285 Kg)	556 lbs (253 Kg)
Pressure Tested at	10 psig	-
Material Specification	SAE 1010 - 1020	-
Paint, Primer Coat as per	TT-P-664	-
Paint, Finish Coat (semi-gloss) as per	MIL-E-7729	-

Table 1-2-5 Power Section Shipping Containers - Leading Particulars

	Metal (Reusable)	Fiberboard (Non-reusable)
Length	53 inches (1346 mm)	48 inches (1212 mm)
Width	36 inches (914 mm)	32 inches (814 mm)
Height	33 inches (838 mm)	31 inches (788 mm)
Weight - approximate	562 lbs (256 Kg)	232 lbs (106 Kg)
Pressure Test at	10 psig	-
Material Specification	SAE 1010 - 1020	-
Paint, Primer Coat as per	TT-P-664	-
Paint, Finish Coat (Semi-gloss) as per	MIL-E-7729	-

Table 1-2-6 Reduction Gearbox Shipping Containers - Leading Particulars



1 STARTER GENERATOR
2 FUEL PUMP & FCU
3 N_g TACHOMETER GENERATOR
4 BLOWER
5 N_f GOVERNOR
6 N_f TACHOMETER GENERATOR

3004

Figure 1-2-1 Accessory Drive Locations

SECTION 3

GENERAL INFORMATION

GENERAL

1 The PT6T-3 Twinned Turboshaft Engine consists of two identical free-turbine turboshaft power sections driving a single output shaft through identical gear-trains in a common reduction gearbox. Each power section includes the associated input driving section of the reduction gearbox. Each power section has two separate turbines; one driving a compressor, and the other driving a turbine shaft coupled to a reduction gearbox input shaft. An accessory gearbox on each power section houses lubrication system pumps and provides mounting pads for fuel control system units. One power section, its accessory gearbox and associated reduction gearbox geartrain, is shown on Figure 1-3-1.

2 Inlet air enters each power section through an annular plenum chamber formed by the compressor inlet case and is directed to the compressor. The compressor, which consists of three axial and a single centrifugal stage assembled as an integral unit, provides a compression ratio of 7:1 at maximum continuous rating.

3 Rows of stator vanes, located between rotor stages, diffuse compressor air, raise its static pressure and direct it to the next rotor stage. Compressed air from the final centrifugal stage passes through diffuser pipes which turn its flow direction through 90 degrees. It is then led through straightening vanes to the combustion chamber liner (see Figure 1-3-1).

4 The combustion chamber liner consists of an annular, reverse-flow weldment, with varying sized perforations to allow entry of compressed air. Air is mixed with fuel and the mixture is ignited within the combustion chamber liner. Air in excess of that required for combustion is directed over the liner surfaces to cool them. Airflows to and from the liner are in opposite directions, and this reversal, together with a second air flow reversal beyond the combustion chamber liner, eliminates the need for a long shaft between compressor and compressor turbine. Power section overall length and weight are thus reduced.

5 Fuel is injected into the combustion chamber liner by 14 simplex nozzles supplied through a dual manifold. Air and fuel mixture is ignited by two spark igniters which protrude into the combustion chamber liner, and resultant gases expand from the combustion chamber liner through compressor turbine guide vanes to the compressor turbine. The guide vanes ensure that expanding gases impinge on the turbine blades at the optimum angle and velocity for minimum energy loss throughout the turbine operating speed range. Expanding gases from the compressor turbine pass rearward through power turbine stator guide vanes to drive the power turbine.

6 Compressor and power turbines are situated in the approximate center of the power section with their shafts extending in opposite directions. Exhaust gas from the power turbine is directed through an exhaust plenum to atmosphere via an exhaust duct and port.

7 Engine-driven accessories, with the exception of the N_f governor, N_f tachometer generator and oil cooler blower, are mounted on the accessory gearbox. They are driven from the compressor by means of a coupling shaft, which extends the drive into the accessory gearbox, and geartrains within the gearbox. End location of these components provides sim[illegible] maintenance.

8 The engine oil supply is contained in thre[illegible] rate oil tanks. Each accessory gearbox contains an integral 1.6 U.S. gallon oil tank, and the reduction gear box contains an integral 1.25 U.S. gallon oil tank. Visual level gages and drain plugs are provided on the oil tanks.

9 The power turbine of each power section drives the reduction gearbox output shaft through a three-stage reduction geartrain. Incorporated in each gear train are: an integral torquemeter device to indicate engine torque, an N_f governor to regulate power turbine rpm, a tacho-generator drive, and a sprag clutch to isolate an inoperative power section.

ENGINE MAIN STATIONS, FLANGES AND BEARING NUMBERS

10 Main stations, flanges and bearing numbers are shown on Figure 1-3-2.

SECTION 4

DETAILED CONSTRUCTION

GENERAL

1 This Section describes in detail all major items of a power section and reduction gearbox.

COMPRESSOR INLET CASE

2 The compressor inlet case (see Figure 1-4-1) is a circular aluminum alloy casting which forms a plenum chamber for passage of compressor inlet air. A circular large area wire-mesh screen is secured over the case inlet to an inlet fairing supported by six brackets attached to flange F, and to flange G fireseal. On Post S.B.5019 engines, a spray ring is secured to a mounting ring and front fireseal by four nuts and bolts. It is located outside and around each power section to form a ground-operated compressor wash system. A tube cap seals off the inlet connection when not in use.

3 No.1 bearing, bearing supports, and labyrinth air seal are contained within the inlet case centerbore. The bearing outer support is bolted to the inlet case centerbore flange and forms a compressor hub assembly cover together with the bearing inner housing. A ring nut and locating rivet retain the bearing outer race in its support housing (see Figure 1-4-2).

4 An oil nozzle, located at the end of a passage in the accessory gearbox housing, provides lubricating oil for No.1 bearing at approximately the 11 o'clock position. A cored outlet port at the 6 o'clock position takes scavenge oil to the accessory gearbox sump. Oil is prevented from entering the compressor by the labyrinth air seal, and compressor interstage pressure air for this is vented to the accessory gearbox through passages in the seal assembly and breather holes in the inlet case centerbore flange.

5 The accessory gearbox is secured to the compressor inlet case at flange G on inlet case studs. A shoulder pin at approximately the 6 o'clock position ensures correct location of the accessory gearbox on the inlet case. The inlet case is secured to the gas generator case at flange F.

COMPRESSOR ROTOR AND STATOR ASSEMBLY

6 The compressor rotor and stator assembly consists of three axial rotor stages, three inter-

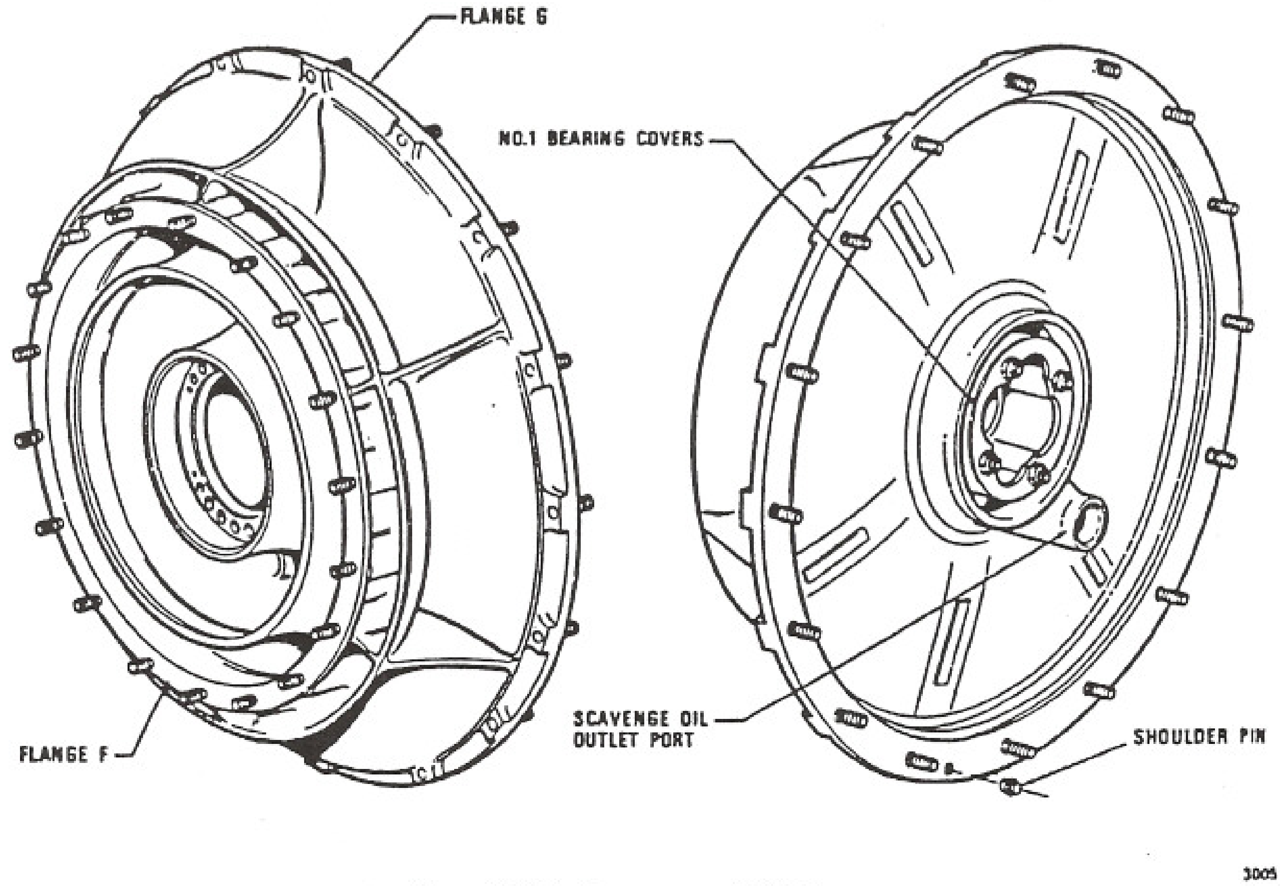


Figure 1-4-1 Compressor Inlet Case

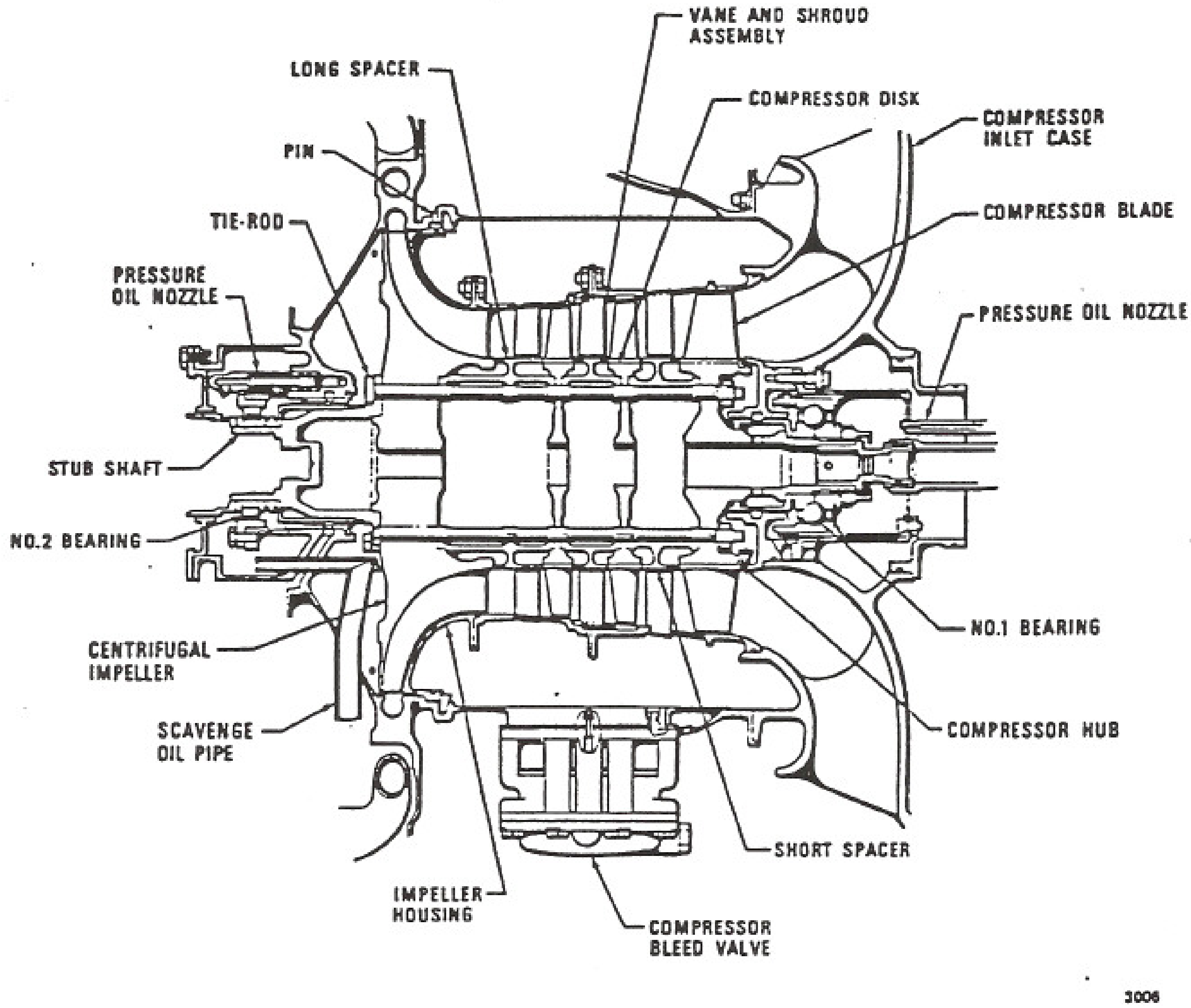


Figure 1-4-2 Compressor Assembly Cross-Section

stage spacers, three stator assemblies and a single-stage centrifugal impeller and housing. First stage rotor blades are manufactured of titanium, second and third stage blades of cadmium plated stainless steel. Blades fit into dovetail grooves machined in rotor disk rims, and the limited clearance between blade root and groove produces the characteristic metallic clicking heard during compressor rundown. Blade axial movement is limited by interstage spacers between disks. The airfoil cross-section of first stage blades differs from that of second and third stage blades, and blade length decreases progressively from first stage to third.

7. Each set of compressor stator assembly vanes is held in position by a circular ring through which vane ends protrude and to which they are brazed. The first stage compressor stator assembly provides a shroud for the first and second stage rotor blades, and the third stage vane and shroud assembly provides a shroud for the third stage blades. First and third stage assemblies are bolted together, and the third stage vane and shroud assembly is secured to the impeller housing. The second stage compressor stator assembly is housed between first and third stage assemblies and located by a single staked pin. Interstage pressure air ($P_{2.5}$) is vented to the compressor bleed valve chamber in the gas generator case through slots in the third stage vane and shroud assembly.

8 Compressor stubshaft, centrifugal impeller, and impeller housing are positioned in that order, followed sequentially by an interstage spacer, a stator assembly and a rotor disk. The rotating assembly is stacked and secured together by six tie rods which are numbered during initial assembly. The impeller housing is secured in the gas generator case by a retaining ring. The head of a stainless steel pin in the gas generator case locates in an

impeller housing slot and prevents housing rotation in the case. The compressor stubshaft is a hollow steel forging, machined externally to accommodate No. 2 bearing and bearing double labyrinth air seal rotor. The bearing, a roller type, supports the compressor stubshaft and its attached turbine in the gas generator case centerbore. The outer flange of the bearing is attached to the gas generator centerbore by bolts and tab-washers. The bearing inner race is located between labyrinth air seal rotors. These rotors are butted against a shoulder on the compressor stubshaft and a shoulder on the compressor turbine stubshaft.

9 The compressor hub is an integral part of the first stage compressor rotor disk. It is a hollow steel forging, machined externally to accommodate No. 1 bearing, labyrinth air seal rotor and a spacer. The bearing, a ball type, supports the compressor hub assembly in the inlet case centerbore. The bearing outer race is held in position against a shoulder in the bearing support inner housing, and secured by a ring nut and rivet. The bearing labyrinth air seal rotor, a spacer, and bearing split inner race are secured in that order against a shoulder on the compressor hub assembly by a cup washer and spanner nut. A groove on the outside circumference of the split inner race facilitates removal by means of a puller. A short, hollow, steel coupling, externally splined at its protruding end, is secured within the hub by a transverse pin through hub and coupling.

10 The complete compressor rotor and stator assembly is installed in the gas generator case, which forms a compressor housing, and secured by the impeller housing and the compressor inlet case.

GAS GENERATOR CASE

11 The gas generator case consists of two stainless steel sections fabricated into a single structure (see Figure 1-4-3). Diffuser pipes, brazed inside the case center section, increase the static pressure of compressed air from the compressor impeller and direct it through straightening vanes to the combustion chamber. P_3 air for the fuel control pneumatic system is vented from a diffuser pipe at the 8 o'clock position and taken by an internal pressure tube to an outlet at the 7 o'clock position on the gas generator case. A second boss at the 7 o'clock position opens directly into the pressurized area of the gas generator case and provides P_3 to pressurize internal carbon seals in the reduction gearbox. Pressurized air to operate the compressor bleed valve, which is secured by four bolts to a port at the 5 o'clock position on the case, is taken via an internal pressure tube from the space behind the diffuser pipes. A boss at the 11 o'clock position makes

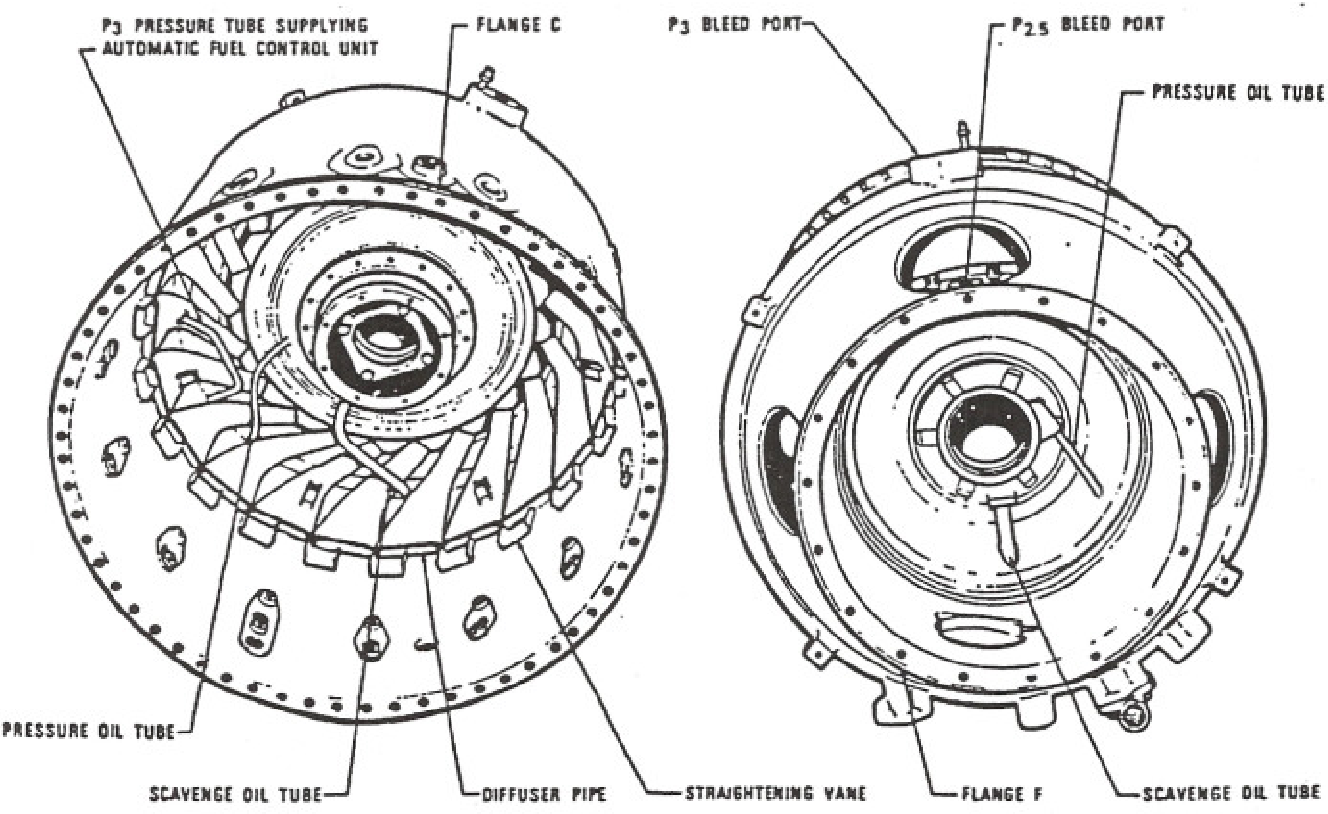


Figure 1-4-3 Gas Generator Case

P_3 air from diffuser pipes available for aircraft use.

12 No. 2 bearing and its two labyrinth air seals are located in the case centerbore. The bearing has a flanged outer race bolted to the case centerbore. Bolts secure the single labyrinth air seal stator to the centerbore and a retaining ring secures the double labyrinth air seal stator. Pressure oil to lubricate No. 2 bearing is conveyed from an inlet port at the 7 o'clock position through an internal pressure tube to a passage in the case centerbore, and then to a double nozzle assembly at the 10 o'clock position. Scavenge oil is taken through an internal tube at the 6 o'clock position to an outlet at the 5 o'clock position.

13 Part of the gas generator case forms the outer housing for the combustion chamber liner. The case is circular, with mounting bosses for 14 fuel nozzle assemblies and two drain valves. Two spark igniters protrude through the case and into the combustion chamber liner at 4 o'clock and 11 o'clock positions to ignite the fuel/air mixture.

COMBUSTION CHAMBER LINER

14 The combustion chamber liner is an annular heat-resistant steel liner, open at one end and domed at the other (see Figure 1-4-4). Rings of plain, plunged and shielded perforations, located around inner, outer and domed circumferences, allow air to enter the liner and provide optimum fuel/air ratios for starting and sustained combustion. Cooling rings control air flow within the liner and, together with the perforations, ensure an even temperature distribution at the compressor turbine inlet. The domed end of the liner is supported inside the gas generator case by seven of 14 fuel nozzle sheaths, and located by the two spark igniters. Open end inner and outer circumferences are located by sliding joints in small and large exit ducts respectively.

LARGE (OUTER) AND SMALL (INNER) EXIT DUCTS

15 Large and small exit duct assemblies together form an envelope which changes gas flow direction by providing an outlet to compressor turbine guide vanes (see Figure 1-4-5). The large exit duct assembly contains a heat shield assembly that forms a passage through which cooling compressor discharge air is routed. Brackets, located on gas generator case diffuser pipes, retain the outer circumference of the duct, and bolts secure it to the case centerbore flange. The small exit duct assembly is bolted to the compressor turbine guide vane support.

COMPRESSOR TURBINE GUIDE VANE RING

16 The compressor turbine guide vane ring consists of 14, integrally cast, cooled vanes between inner and outer securing rings. External contours of the vanes direct expanding gases from the combustion chamber to the compressor turbine blades at the optimum angle for turbine drive. The vane ring is secured between combustion chamber large exit duct

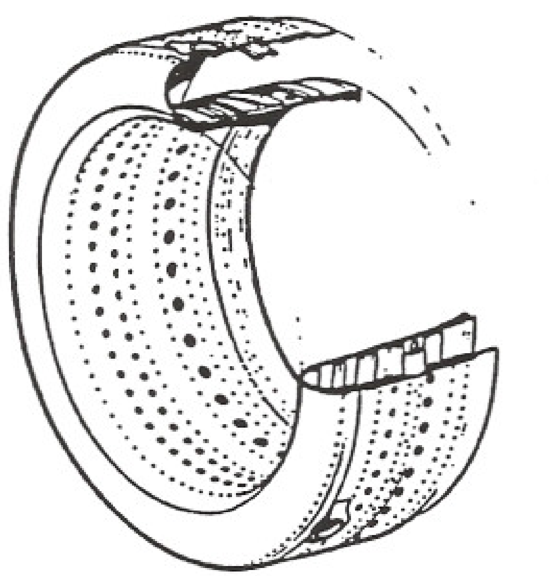


Figure 1-4-4 Combustion Chamber Liner

and No. 2 bearing cover at the gas generator case centerbore. The compressor turbine shroud housing locates the compressor turbine vane ring outer circumference.

17 Cooling air from around the inner combustion chamber liner wall passes through 14 ports in the small combustion chamber exit duct securing flange to matching holes and integral vents in 14 lugs on the vane outer ring. Air then passes through internal passages in each vane to be vented axially from the vane trailing edge root at the inner ring. A blanking plate on each outlet port ensures axial venting and directs the air onto the compressor turbine disk.

18 The compressor turbine shroud housing extends toward the power turbine and is grooved to receive two interstage sealing rings. These provide a point of mechanical separation and power seal between gas generator and power turbine in the power section.

COMPRESSOR TURBINE

19 The compressor turbine consists of a two-plane balanced turbine disk with a single shaft extension, blades and classified weights. (See Figure 1-4-5). The turbine drives the compressor in a clockwise direction through its shaft extension which is externally splined to fit within the compressor stubshaft. A master spline ensures relocation of the disk assembly in the same position, to retain original balance. A center bolt and cup washer secure the disk and compressor stubshaft together. The disk embodies a circumferential groove to enable disk growth to be checked. The blades of the turbine are secured in fir-tree serrations machined in the disk outer circumference, and held in position by individual tubular rivets. Blades are machined from

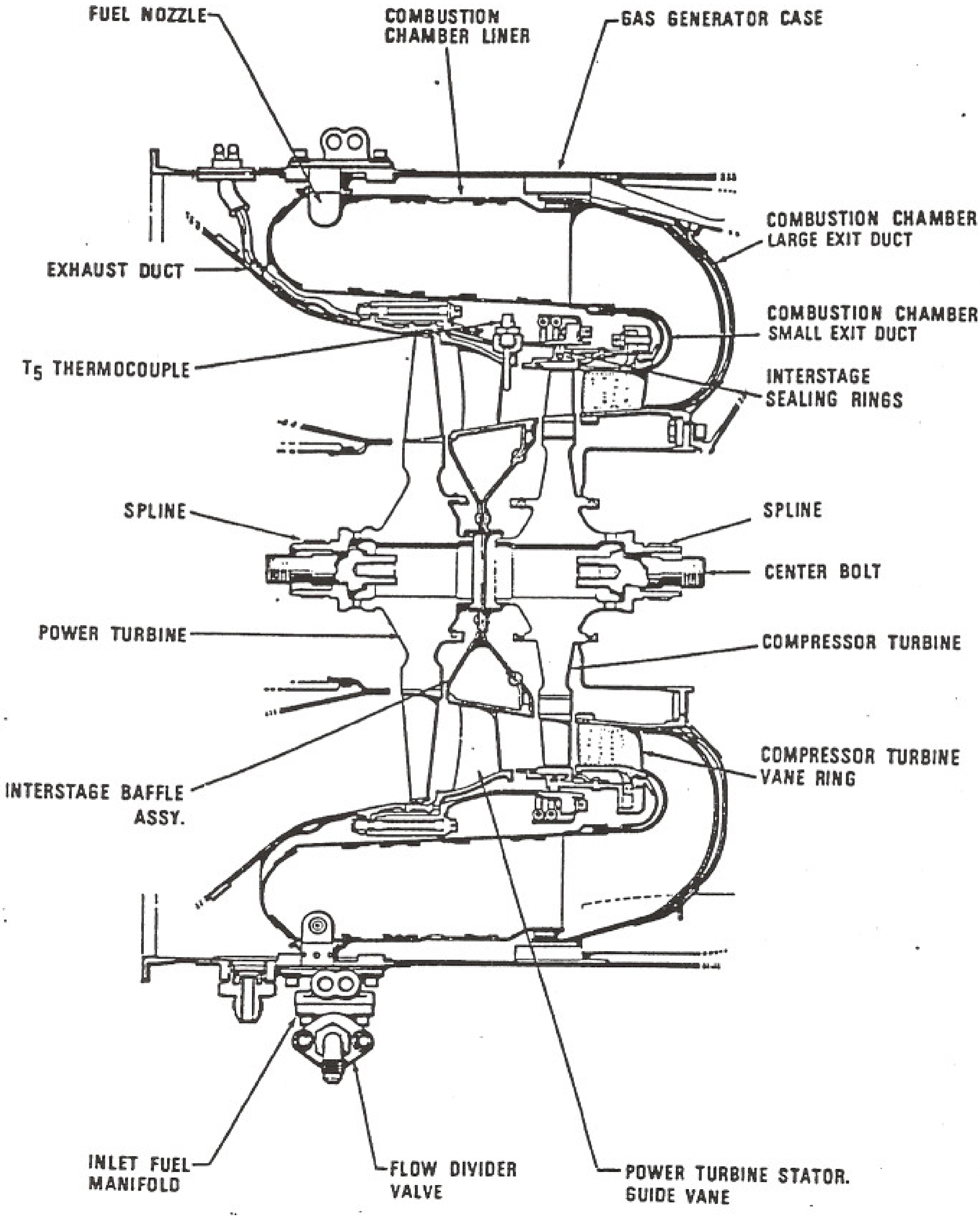


Figure 1-4-5 Combustion Chamber and Exit Ducts Cross Section

nickel-cobalt alloy castings, and include squealer tips to ensure minimum damage should blades contact shroud segments. A spot face machined on each blade tip enables blade stretch to be checked. Classified balancing weights are riveted to relevant flanges on the disk during balancing procedures. An inter-stage baffle between compressor and power turbine disks directs cooling air flow up the trailing face of the compressor turbine disk and the leading face of the power turbine disk and acts as a seal between the two turbine stages.

POWER TURBINE GUIDE VANE RING

20 The power turbine guide vane ring is located by a flange on its outer ring that is retained between the power turbine shroud and the stator housing flange inside the exhaust duct Flange D (see Figure 1-4-5). Lugs on the inner ring prevent baffle assembly rotation relative to the guide vane ring, and slots in the outer ring flange mate with the lugs of the stator housing. The combined assembly is retained by flange ring securing bolts through the exhaust duct flange. Slots through the outer ring, upstream of the guide vanes, allow T_5 temperature probes access to inter-turbine gases. Integrally cast vanes direct gas flow to the power turbine at the optimum angle for turbine drive.

POWER TURBINE

21 The power turbine disk assembly consists of a turbine disk, blades and classified weights. (See Figure 1-4-5.) The disk drives a reduction gearbox input shaft, through a power turbine shaft and a coupling shaft, in a counterclockwise direction. The disk embodies a circumferential groove to enable growth measurements to be taken. Turbine disk and shaft are splined together, and the disk extension shaft is secured inside the turbine shaft by a single center-locking bolt and cup washer. A master spline ensures that the turbine disk is always installed in the same position. The required number of classified balancing weights are riveted to a flange on the leading face of the turbine disk during balancing procedures. Power turbine blades differ from compressor turbine blades in that they are cast with notched and shrouded tips. The blades are held in fir-tree serrations in the turbine disk and secured by individual tubular rivets. Blade tips rotate inside a double knife-edge shroud to form an air seal when running, thereby increasing turbine efficiency by reducing leakage.

POWER TURBINE SHAFT HOUSING

22 The power turbine shaft housing is a fabricated steel cylinder which provides support to the power turbine shaft, No. 3 and No. 4 bearings, a labyrinth air seal at the power turbine disk end, and internal pressure and scavenge oil tubes (see Figure 1-4-6). The housing is attached at flange B to the No. 3 and No. 4 bearing housing support. No. 3 bearing, a roller type, supports the turbine shaft and disk at the turbine disk end, and No. 4 bearing, a ball type, supports the shaft at its gearbox end. No. 3 bearing outer race is secured inside the turbine shaft housing assembly by bolts and keywashers, and its inner race is secured on the turbine shaft between a shoulder and the labyrinth seal rotor. No. 4 bearing outer race is also secured inside the turbine shaft housing by bolts and keywashers, and its split inner race is secured between a shoulder on the turbine shaft, a positioning ring and the coupling shaft. These are secured by a cup washer and spanner nut.

NO. 3 AND NO. 4 BEARING HOUSING SUPPORT

23 The bearing housing support is a conical casting which is secured, together with the exhaust duct assembly, to the reduction gearbox by studs through flange A. (See Figure 1-4-6.) Passages in the housing support carry pressure oil from the reduction gearbox output housing at the 11 o'clock position for lubrication of No. 3 and No. 4 bearings, and to supply the ejector-type pump that scavenges these bearings. As the ejector pump is only efficient at operating pressures, a spring loaded ball-type check valve prevents oil flow which might flood No. 3 and No. 4 bearing compartment during run-up and run-down. During normal operation the check valve is fully open. Scavenge oil is withdrawn from the bearing area by the ejector-type pump, and sprayed into a sump area formed at the bottom of the housing support and reduction gearbox housing.

EXHAUST DUCT

24 The exhaust duct (see Figure 1-4-7) consists of a divergent heat-resistant steel duct, with a single outlet port on top. An insulation blanket is interposed between the inner cone of the exhaust duct and the outer cone of the power turbine shaft housing and support assembly to reduce transmission of exhaust gas heat to the power turbine shaft and bearing area. The power turbine guide vane ring is bolted to the exhaust duct at flange D, and at its outer section the exhaust duct is bolted to the gas generator case at flange C. At flange A, the exhaust duct assembly is secured to the reduction gearbox output housing assembly by studs. A drain hole at the 6 o'clock position allows fuel, accumulated during engine shut-down, into the gas generator case and out through the drain valve.

REDUCTION GEARBOX

25 The reduction gearbox (see Figure 1-4-8) consists of five castings, an output housing, a diaphragm, an input housing, and two covers. The output housing is secured to each power section at flange A. Input and output housings are secured together by studs, and the diaphragm is interposed between them. Covers are secured to the input housing to provide accessory mounting pads, and to protect reduction gearshaft bearings. Each power section reduction geartrain consists of three gearshafts, driving a common output shaft. Accessory drives, for N_f governor, tacho-generator, and blower are taken from the second stage of each reduction geartrain.

26 Each gearbox input shaft carries a single spur gear, and is supported by No. 5 and No. 6 bearings. No. 5 bearing is a duplex ball bearing mounted on the

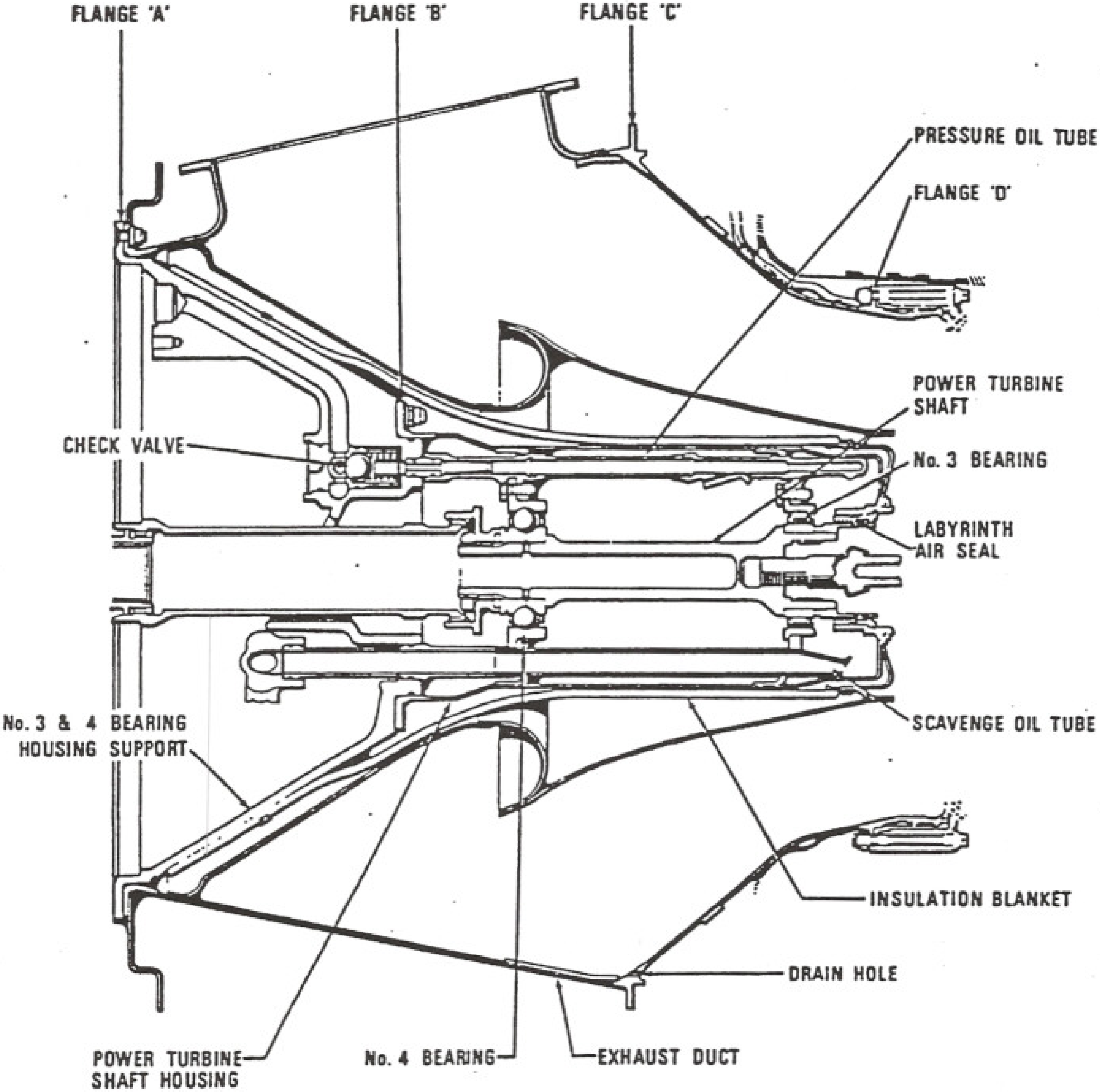


Figure 1-4-6 Power Turbine No. 3 and No. 4 Bearing Area

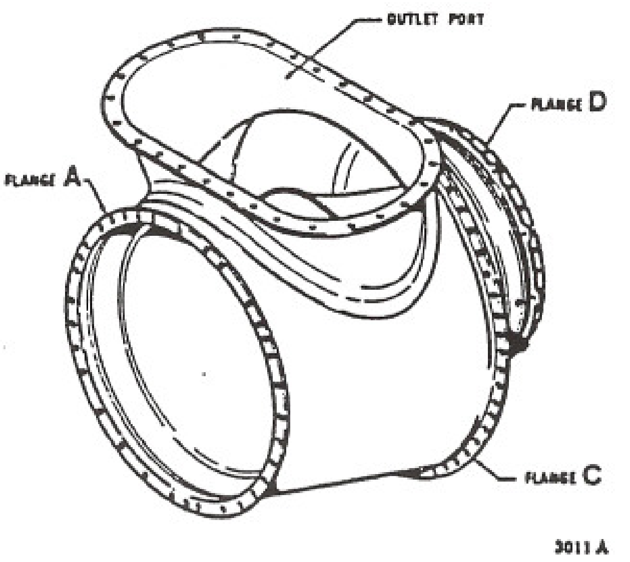


Figure 1-4-7 Exhaust Duct

diaphragm, and No. 6 bearing is a roller bearing mounted on the input housing. The input shaft spur gear meshes with the larger of two spur gears on the second stage shaft, which is supported by No. 7 and No. 8 bearings. No. 7 bearing is a roller bearing mounted on the diaphragm, and No. 8 is a duplex ball bearing mounted on the input housing. The larger spur gear on the second stage shaft transmits drive to an independently mounted clutch gear on the composite third reduction stage shaft, and the smaller second stage spur gear transmits drive to a blower gear through an idler gear, and to the power turbine governor gear through the tacho-generator drive gear. Idler gear and blower gear are mounted in roller bearings, and tacho-generator and governor gearshafts are supported in journal bearings.

27 The clutch gear is supported in roller bearings No. 10-1/2 and No. 12-1/2 which are mounted on the input housing and diaphragm, respectively. A sprag clutch, housed in the clutch gear, transmits the drive from this gear to the clutch drive shaft (see Figure 1-4-8). The center of gravity of each sprag is arranged in relation to the centers of curvature so that under centrifugal force the sprag tilts toward the upright position, causing the sprags to engage the inner race (shaft) and outer race (clutch gear). Under normal operating conditions, i.e., when the clutch gear (outer race) is driven by the engine, the clutch sprags are engaged, transmitting the drive from the clutch gear directly to the shaft (inner race). Should one power section fail, the clutch drive shaft of that section will assume the driving instead of the driven mode. This action allows the sprags to tilt in the opposite direction, leaving the clutch and the clutch gear (outer race) free. The clutch drive shaft is supported in the clutch gear by ball bearings No. 11 and No. 12. No. 10 bearing transmits axial movement from clutch drive shaft to torquemeter piston during changes in torque. (See Figure 1-4-8.) An intermediate drive shaft, splined within the clutch drive shaft, is secured against a shoulder of the shaft by a nut and keywasher at the torquemeter end. A helical gear, mounted within roller bearings No. 13 and No. 14 on diaphragm and output housing, respectively, is splined onto the intermediate drive shaft. Spiral retaining rings, in slots within the helical gear, secure the gear to the shaft.

28 The helical gear meshes with the output shaft gear. Changes in transmitted torque are thus converted into axial movement of the helical gear, intermediate drive shaft, clutch drive shaft and torquemeter piston. A torquemeter valve on the piston cover moves within a sleeve to produce a change in oil pressure signal to torque control unit and airframe instruments (see Figure 1-4-10). The output shaft has a single helically toothed spur gear with which third stage gears mesh (see Figure 1-4-8). The shaft is supported on roller bearings No. 15 mounted on the diaphragm, and roller and ball bearings No. 16 and No. 17, respectively, mounted on the output housing. An insert in the output shaft extends into the input housing to drive the reduction gearbox oil system pump.

29 Three lubrication systems supply the reduction gearbox, each power section oil system lubricates its gearbox input section, and the reduction gearbox oil system lubricates output shaft and third stage bearings. A linking, tube housing, at the bottom of each input section, connects a pressure oil transfer tube from each power section accessory gearbox to a transfer tube to the oil cooler. The output housing has internal passages to carry pressure oil from each oil filter to an external transfer tube, and separate oil passages to take pressure oil internally from each filter to No. 3 and No. 4 bearings, and the bearings of each input section. Scavenge oil from No. 3 and No. 4 bearings is sprayed into a sump area formed at the bottom of the gearbox output housing, and scavenge oil from gearbox input section bearings drain under gravity into this area.

30 The gearbox lubricating oil pump is a gear type pump mounted on the input housing side of the diaphragm. It circulates oil to output shaft bearings, and the bearings of each power section third stage reduction composite shaft. Oil from bearings returns under gravity to an oil tank at the bottom of the input housing for recirculation by the pump.

ACCESSORY GEARBOX

31 The accessory gearbox is formed from housing and cover magnesium alloy castings. Cover and housing are secured together by studs, and the housing is secured to the compressor inlet case at flange G by studs. (See Figure 1-4-11.) Roller bearings supporting idler, starter, fuel pump, and N_g tacho-generator gearshafts are mounted on cover and housing. The ball bearing supporting the accessory gearbox input shaft is mounted on the cover. An integral oil tank is incorporated in the gearbox housing.

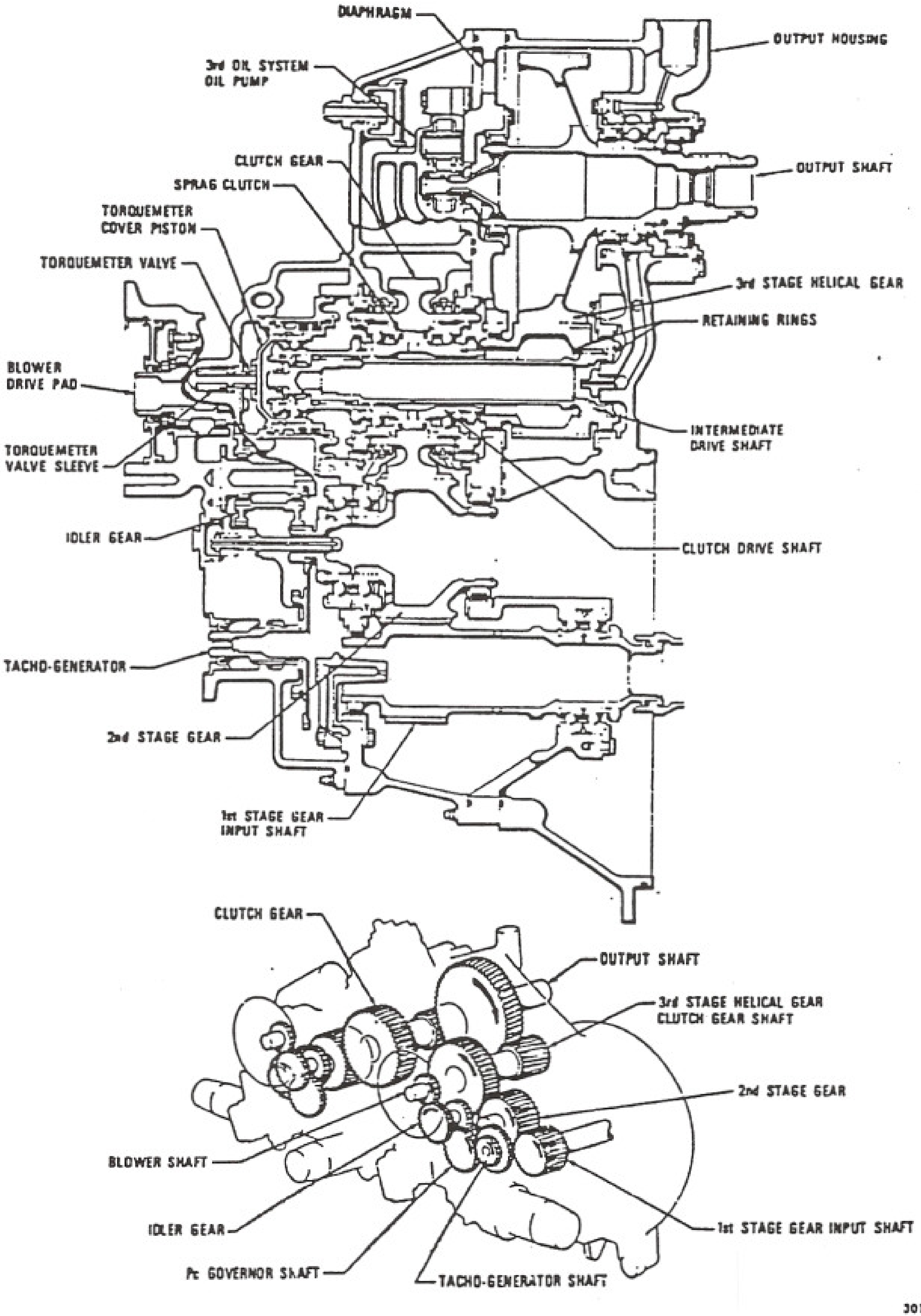


Figure 1-4-8 Reduction Gearbox

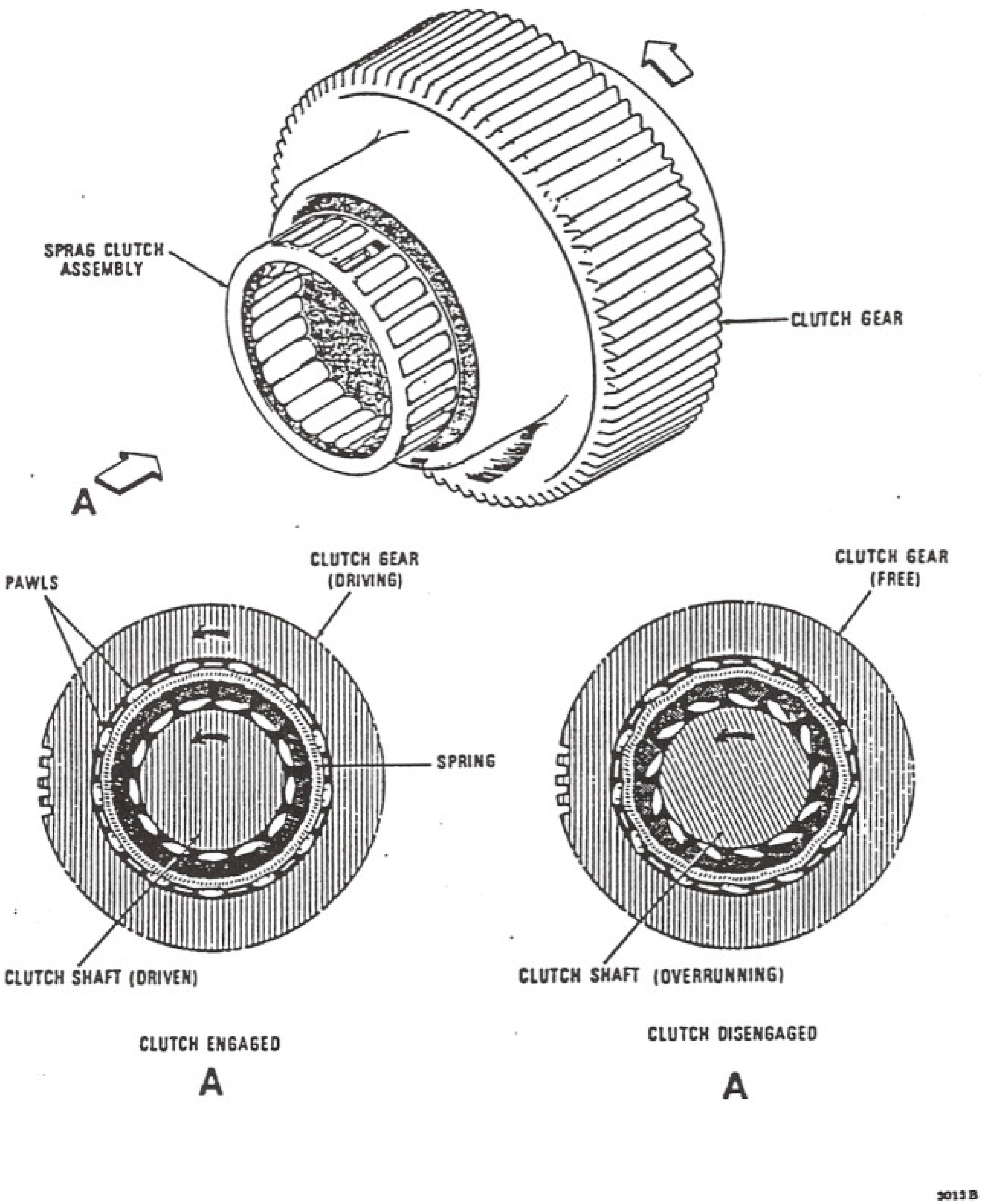


Figure 1-4-9 Sprag Clutch Operation

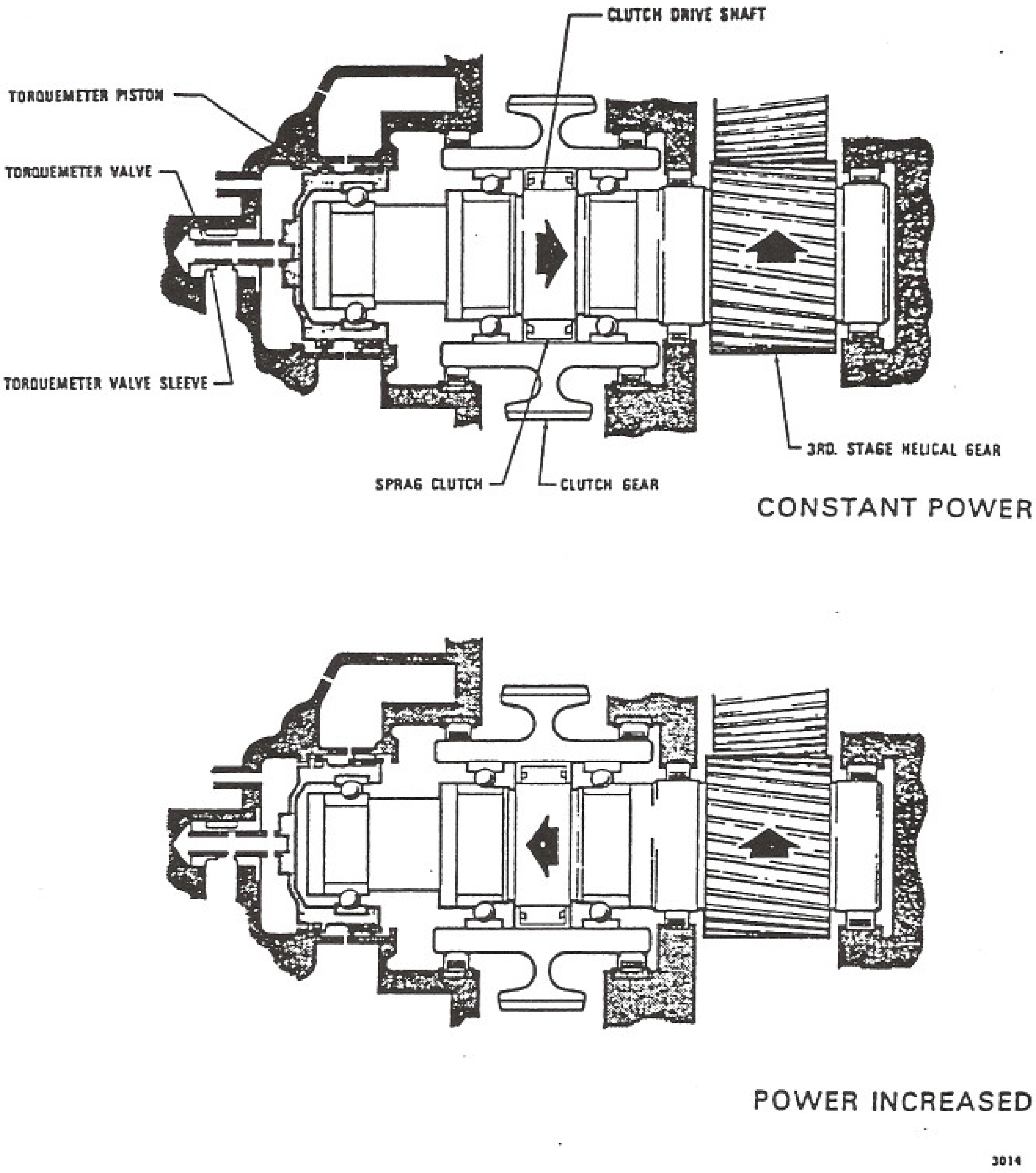


Figure 1-4-10 Torquemeter Operation

32 Internal cored passages and pressure tubes take pressure oil to No. 1 bearing, and return scavenge oil, by gravity, to the accessory gearbox sump. Pressure oil to the power section and reduction gearbox input section bearings, and scavenge oil from them, is taken through external pipes. All three scavenge pumps and the pressure pump are mounted on a common shaft driven from the first stage idler gear as shown on the geartrain schematic. (See Figure 1-4-11.) Oil tank filler tubes and apertures for visual contents gages are situated on either side of the housing casting, and those not in use, the inner ones, are blanked off. A centrifugal breather impeller mounted on the starter-generator drive gearshaft separates oil and power section breather air in the gearbox housing. A cored passage allows air to be vented from the top of the housing. A carbon face seal on the gearbox housing end of the gearshaft prevents oil leakage through the bearing assembly. An external line takes pressure oil from the accessory gearbox check and regulating valve housing to the fuel heater.

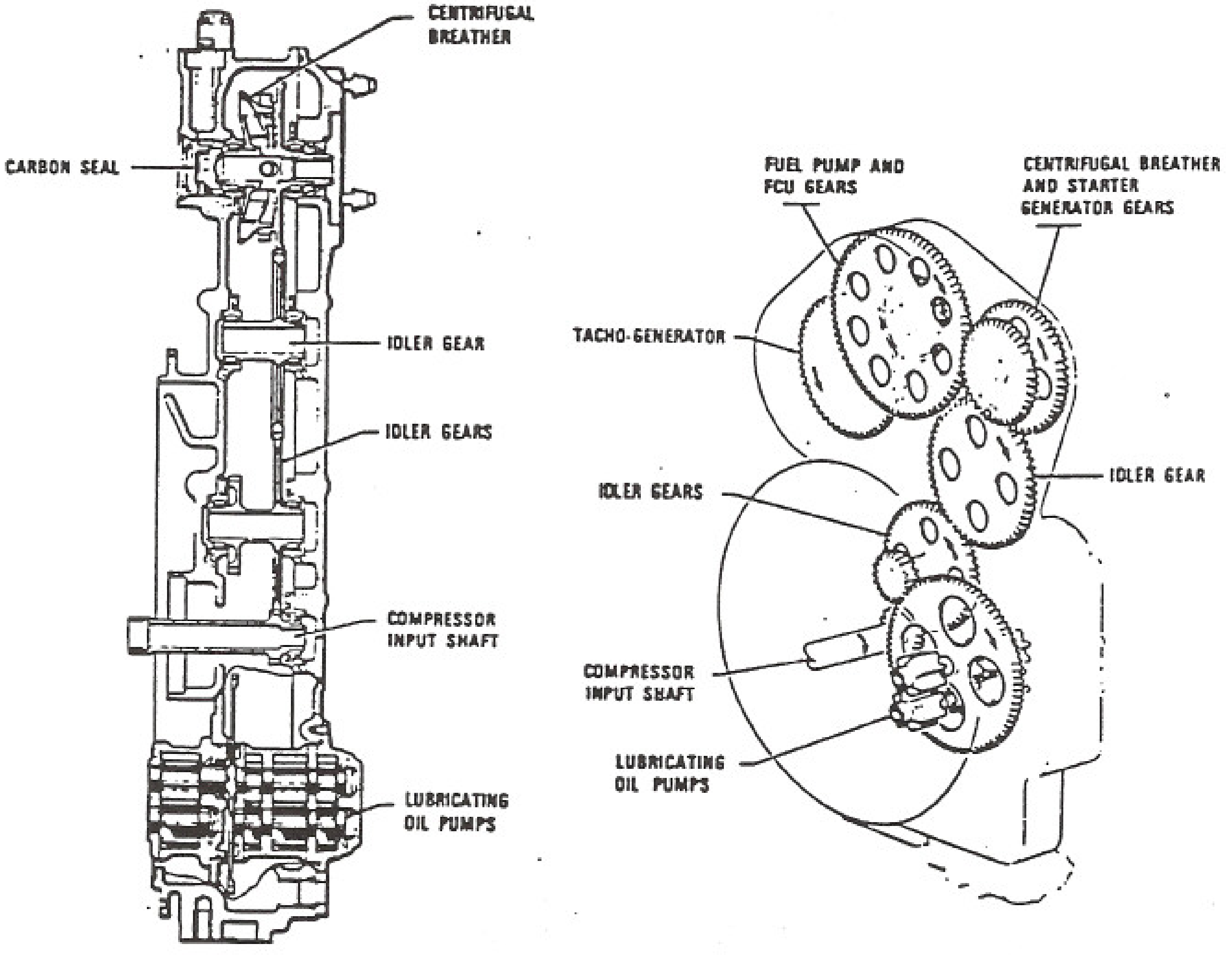


Figure 1-4-11 Accessory Gearbox

SECTION 5

AIR SYSTEMS

GENERAL

1 Each power section has three basic internal air systems; a compressor interstage air bleed system, labyrinth air sealing for No. 1, 2 and 3 bearing compartments, and a turbine vane and disk cooling system. Compressor discharge air for the pneumatic fuel control system, and pressurizing carbon seals in the reduction gearbox, is taken from bosses on the gas generator case. An optional source of compressor discharge air is provided on the gas generator case at the 11 o'clock position, but may be blanked off if not required.

COMPRESSOR BLEED VALVE

2 The compressor bleed valve is secured by bolts over a port at the 5 o'clock position on the gas generator case inner section. The valve opens to spill interstage compressor air (P2.5) at low compressor speeds, and thereby provide anti-stall characteristics. At higher speeds the valve remains closed.

3 The valve is a piston-type in a ported housing. The piston is supported by a rolling diaphragm which permits full travel in either direction, while effectively sealing the compartment below the piston (see Figure 1-5-1). Compressor interstage air is supplied directly to the valve from slots in the compressor third stage vane and shroud assembly, and compressor delivery air (P_3) is supplied from gas generator case diffuser pipes via an internal pressure tube.

4 Compressor interstage air ($P_{2.5}$) pressurizes the top side of the piston; P3 air is taken through a primary orifice to a convergent-divergent orifice, which vents to atmosphere. The control pressure (P_x) arrived at between primary and convergent-divergent orifice is used to pressurize the underside of the piston. When P_3 reaches a pre-selected value, the convergent-divergent orifice becomes choked and pressure below the piston increases to close the valve. Below the pressure at which the orifice becomes choked, interstage pressure moves the piston down sufficiently to allow venting to atmosphere. Compressor operation is dependent on ambient inlet pressure, and the use of a choked orifice allows automatic altitude compensation. The ratio between ambient and P_3 pressure necessary to choke the convergent-divergent orifice is constant, and consequently, the valve will close at a slightly lower P_3 pressure at altitude than at ground level.

BEARING COMPARTMENT SEALS, TURBINE COOLING SYSTEMS

5 Pressurized air is used to seal No. 1, 2 and 3 bearing compartments, and to cool compressor and power turbines and compressor turbine guide vanes (see Figure 1-5-2). Labyrinth airseals protect bearing compartments, and consist of plain rotating surfaces within stationary circular seals with deep annular grooves machined inside the bore. When parts are matched, and the clearance between rotating and stationary parts kept as small as possible, the air pressure drop across the seal prevents passage of oil when the power section is running.

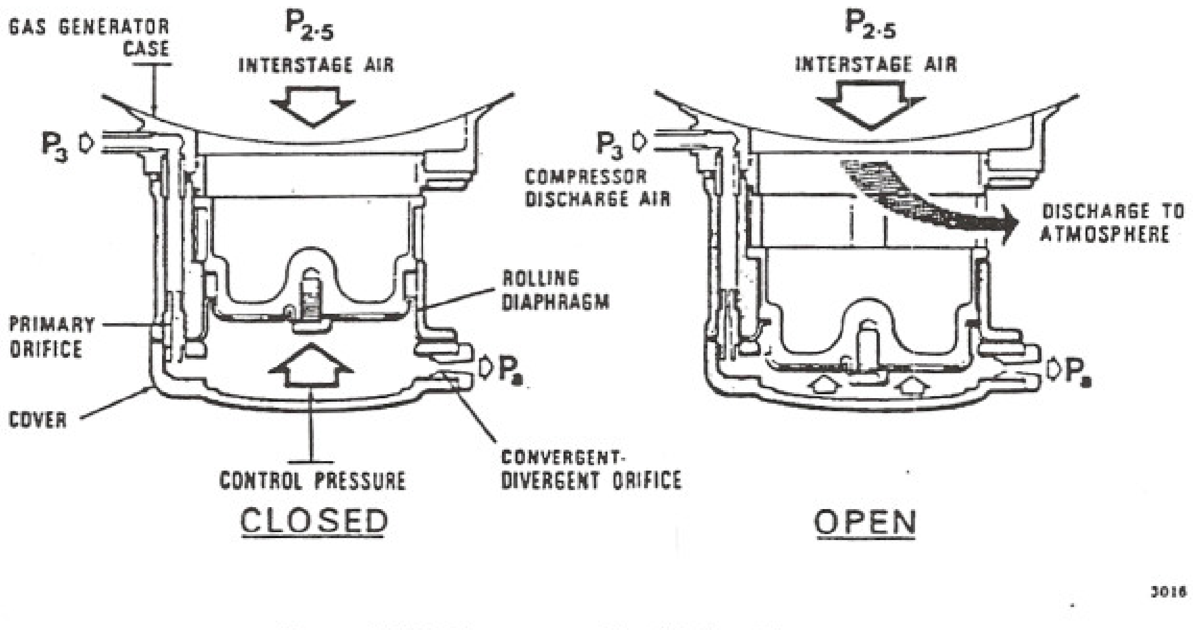


Figure 1-5-1 Compressor Bleed Valve Schematic

6 Compressor interstage air is used to provide a pressure drop across the No. 1 labyrinth air seal. The air is taken, via holes in the third stage compressor spacer disk through the center of the compressor disks to outlet holes in the compressor hub. The compressor hub and sleeve have slots which allow air to the center of the double stator seal assembly, and air passes outward across both halves of the seal. Air across one half of the seal is returned to the main air flow before the compressor first stage rotor. Air across the other half seal passes through holes in the air seal stator, and matched holes in the compressor inlet case centerbore flange, to the accessory gearbox housing.

7 No. 2 bearing compartment is sealed by a double labyrinth air seal, and a single labyrinth air seal. P_3 air from around the combustion chamber outer exit duct passes through holes in the gas generator case centerbore outer flange, and pressurizes the double labyrinth air seal via hollow struts in the bearing compartment support housing. Air passes from the seal central groove outward through half the seal to rejoin the main air stream at the centrifugal impeller exit, and inward through half the seal, to be scavenged with oil.

8 The P_3 air stream which pressurizes the seal, also passes down the leading face of the compressor turbine to cool it. Pressure differential across No. 2 bearing seal is provided by part of this air stream flowing into the bearing compartment. The main air flow is through holes in the compressor stub shaft to the centerbore of both turbine disks. Air passes outward between the disks to cool their surfaces, and through holes in the power turbine stub shaft to pressurize No. 3 bearing labyrinth seal.

9 No. 3 bearing compartment is sealed from the power turbine by a double labyrinth seal. Air passes outward through half the stator to join the main air stream through the power section, and inward to seal the bearing compartment.

10 Compressor discharge air for the fuel control system is taken from a diffuser pipe to a boss at the 7 o'clock position on the generator case to an air manifold adapter and the reset regulator of the AFCU. Metered air from the regulator is taken to the power turbine governor and torque control unit on the reduction gearbox. Compressor discharge air for pressurization of clutch carbon seals in the reduction gearbox is taken from a second boss at the 7 o'clock position on the gas generator case, directly to the reduction gearbox.

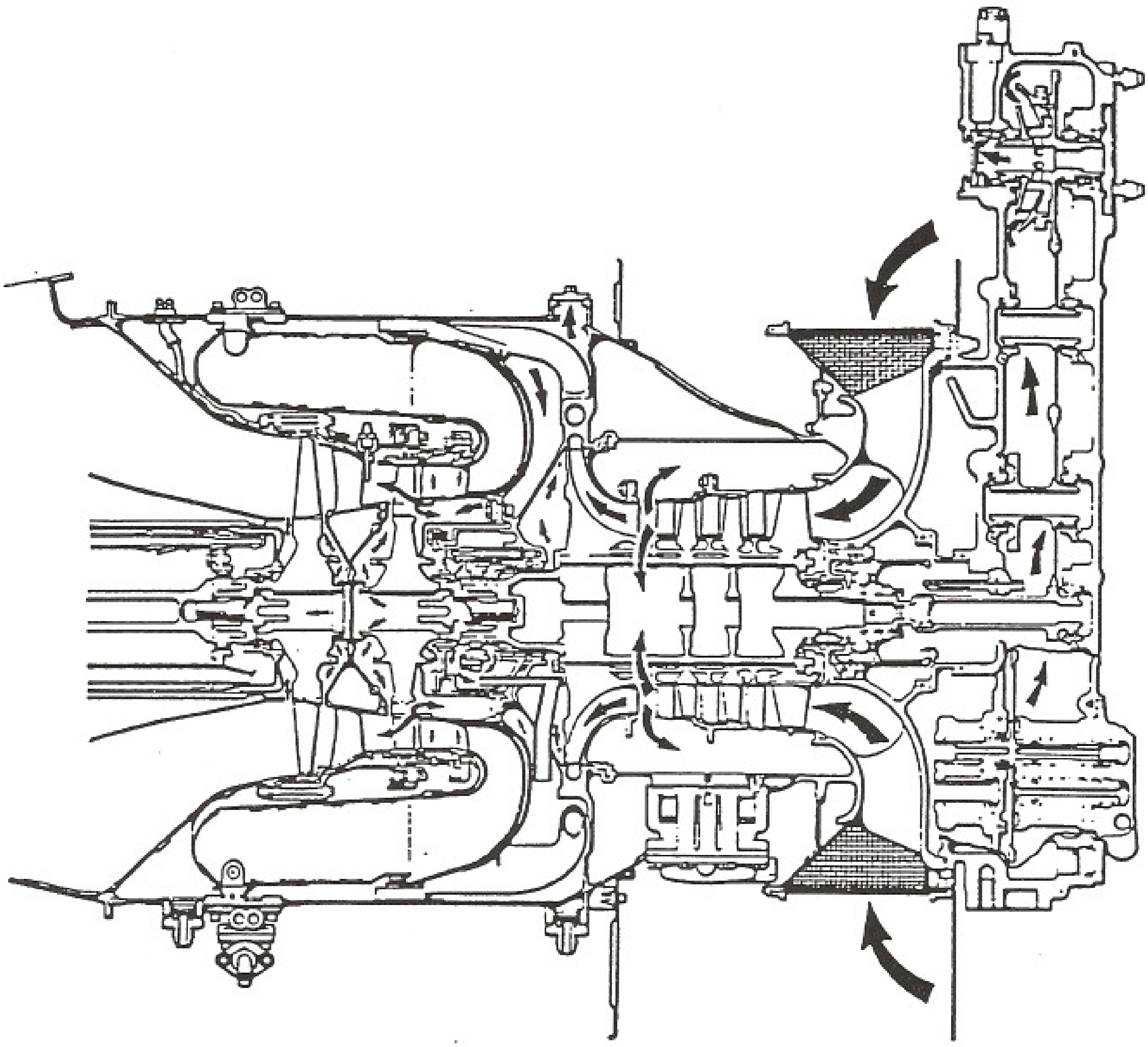


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Figure 1-5-2 Bearing Compartment Seals, Turbine Cooling and Air Bleed Systems

SECTION 6

LUBRICATION SYSTEMS

GENERAL

1 The PT6T-3 has three separate lubricating systems. Identical systems lubricate their associated power section and input section of the reduction gearbox. A third system lubricates the reduction gearbox output section. Oil lubricates and cools bearings and conducts any foreign matter to oil filters where it is precluded from further circulation. Calibrated oil nozzles are used on main engine bearings to ensure that an optimum oil flow is maintained. A main pressure pump supplies oil in each system, and scavenge pumps retrieve oil from power section bearings. Chip detector units, three in the reduction gearbox and one in each accessory gearbox, incorporate a self-closing device to eliminate draining oil, when removing chip detector for inspection (see Figure 1-6-1).

POWER SECTION LUBRICATION SYSTEM

2 The power section lubrication system pressure pump and three scavenge pumps are mounted in the accessory gearbox, which also houses an integral oil tank. The filter is mounted on a cover of the reduction gearbox.

OIL TANK

3 The oil tank is an integral part of the accessory gearbox assembly, its faces being formed by the compressor inlet case and the accessory gearbox housing casting (lower half). The tank has a total capacity of 1.6 U.S. gallons of which 0.75 U.S. gallon is usable oil. An expansion space of 0.5 U.S. gallon is provided.

4 The oil tank is provided with an oil filler neck on either side, one of which is blanked off, and houses bosses for two visual oil level indicators, one of which is blanked off. A snap-type filler cap and strainer element is fitted in the tank filler neck in use. A drain plug in the bottom of the tank facilitates oil drainage.

OIL PUMP

5 Pressure oil is circulated from each integral oil tank through its respective power section lubricating system by a self-contained gear-type pressure pump mounted on a boss on the rear face of the accessory gearbox housing casting. An oil pump inlet, with removable screen, is supplied with oil from the lowest part of the tank. An outlet supplies pressure oil to a cored internal passage on the housing which connects with the main check and pressure regulating valve mounted underneath the housing. The drive gear of the main pump and also those of the three scavenge pumps, are mounted on a common shaft.

OIL FILTER ASSEMBLY

6 The oil filter assembly consists of a cartridge-type filter element mounted in a cover assembly secured to the reduction gearbox cover by studs. Pressure oil flows inward through internal cored passages to the space between filter and cover, through the filter, and out through the open filter end to internal casting passages and an external pressure tube to the power section bearings and accessory gearbox. Should the filter restrict the flow a spring-loaded bypass valve, normally closed, will open with increasing pressure against the valve spring to allow oil to bypass the filter from inlet to outlet passages. A small screened orifice on the inlet side of the filter allows controlled leakage of oil and venting of oil vapor into reduction gearbox internal cavities. (See Figure 1-6-2.)

PRESSURE OIL SYSTEM

7 Oil pressure is regulated by a pressure relief valve which forms part of the combined check and regulating valve housing mounted underneath the accessory gearbox. An oil pressure adjustment va- for minor external adjustment is mounted at the to the accessory gearbox. A pressure sensing line, f a tee-piece in the main pressure return line from the reduction gearbox mounted filter, controls movement of a piston to allow pressure oil directly back to the main tank if system pressure exceeds a predetermined value. (See Figure 1-6-3). Pressure oil from the pump normally holds open a check valve piston to allow oil out through an outlet port and external pressure lines to the system filter and to the oil/fuel heater. The check valve cylinder is open to a second cylinder which is normally blocked by a piston controlled by return line pressure. When return pressure from oil system filters is sufficiently high this piston is moved against spring pressure to open a second port and allow pressure oil to flow through a cored passage in the gearbox housing back to the main oil tank. Oil flow through cooler and filter is therefore limited by demand rather than pump capacity.

8 Lubricating oil for power section bearings, other than No. 3 and 4 bearings, is supplied from the oil filter via an external transfer tube that runs the length of the power section. Oil for accessory bearings in the accessory gearbox and No. 1 bearing is taken via internal passages in gearbox castings to two oil jets. One jet sprays bearings in the upper part of the gearbox, and the other sprays bearings in the lower part and No.1 bearing. No.1 be- ing oil is sprayed through a fine strainer and nozz assembly directly on to the bearing races, and on the compressor hub assembly coupling shaft to run grooves to the split inner race (see Figure 1-6-4).

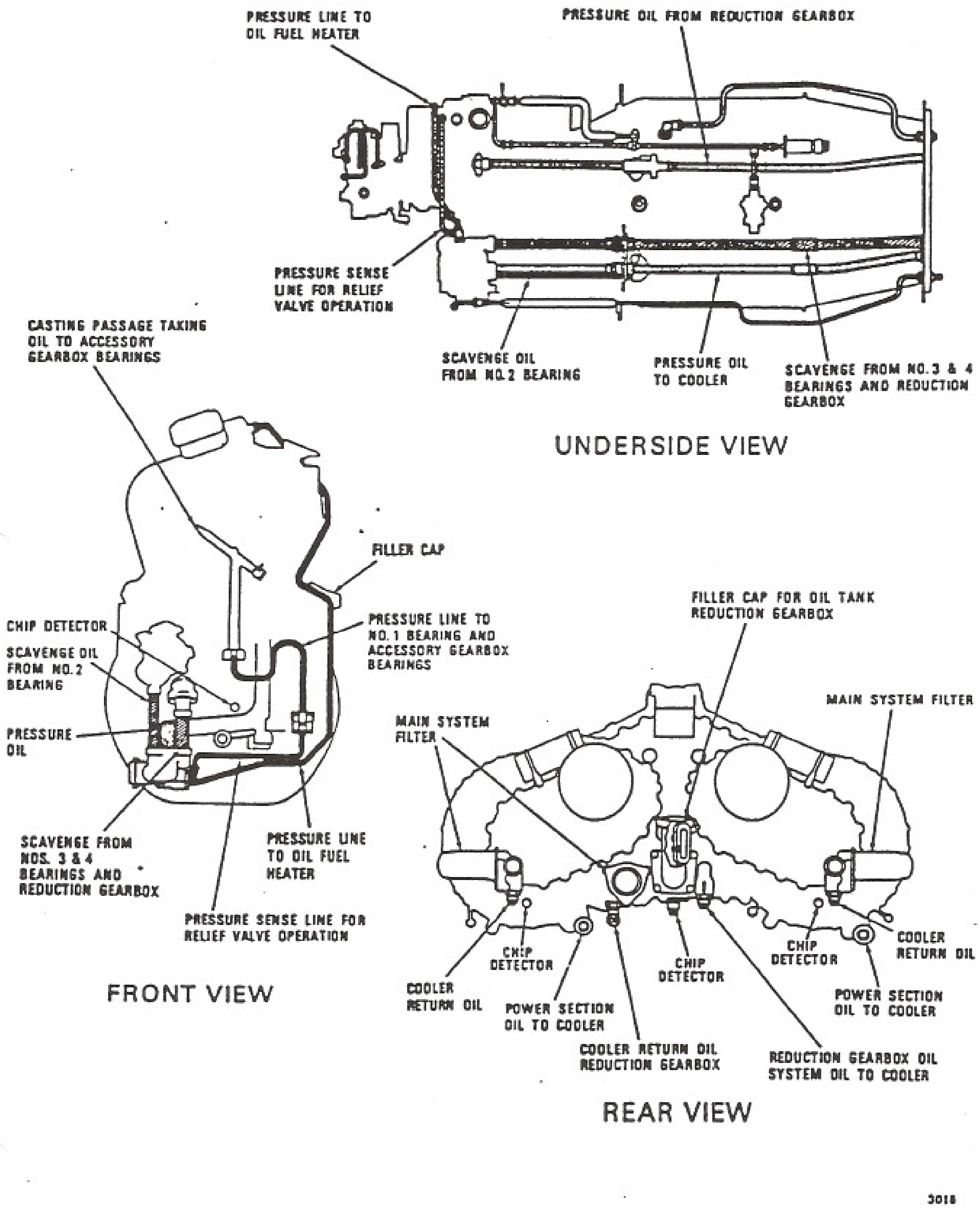

Figure 1-6-1 Lubricating System Components Location

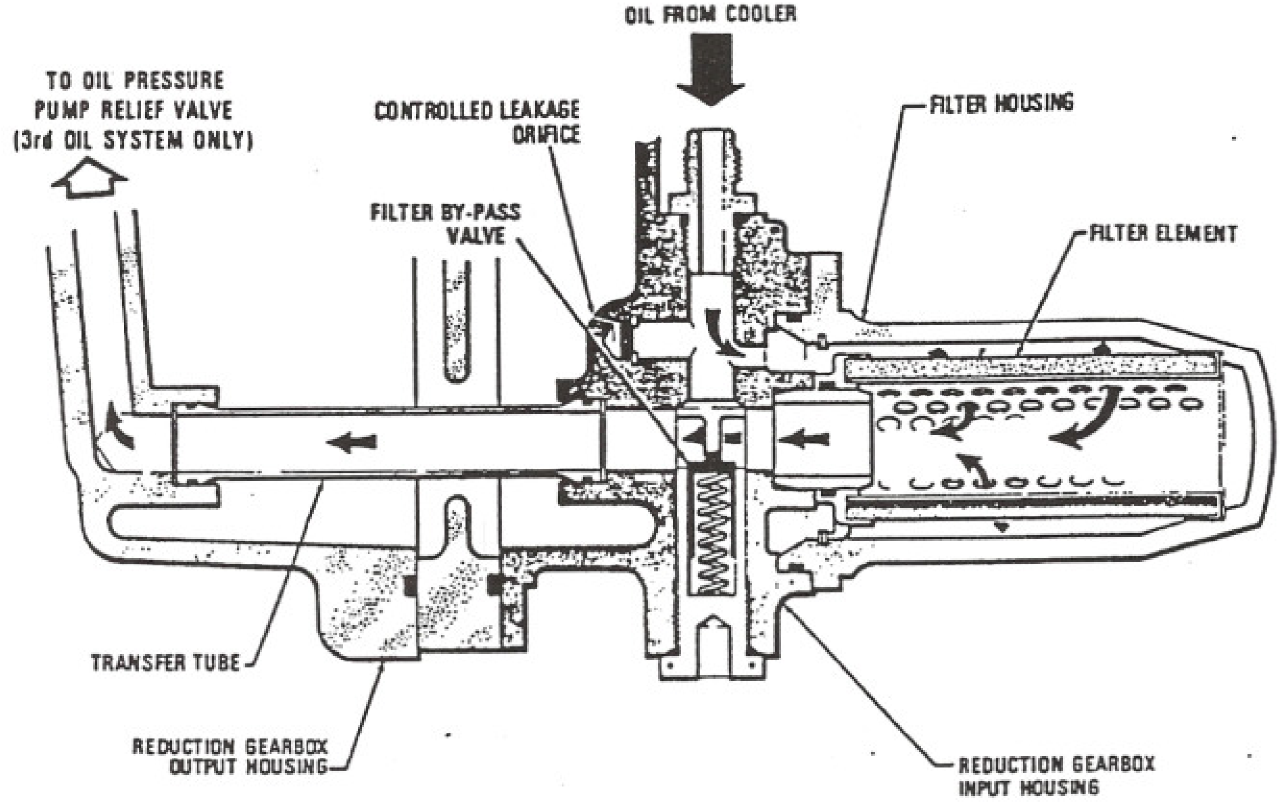

Figure 1-6-2 Filter and Bypass Valve Schematic

9 No. 2 bearing lubricating oil is taken from a tee-piece in the external transfer tube through a boss on the gas generator case at the 7 o'clock position. It is taken internally through a cored passage in the gas generator case centerbore to an oil gallery with two nozzles to lubricate both faces of the bearing.

10 Oil for No. 3 and 4 bearings is taken via internal cored passages in reduction gearbox castings through a minimum pressure valve to an oil gallery at the 12 o'clock position in the bearing housing. Nozzles direct oil to both faces of No. 3 bearing and one face of No. 4 bearing.

11 Pressure oil for reduction gearbox input section bearings is taken from a focal point through four separate casting passages. One passage sprays oil inside the reduction gearbox input shaft to lubricate No. 4 and No. 5 bearings centrifugally, and an offshoot from this passage lubricates No. 6 bearing. Another passage takes oil to cool the meshing teeth of input and second stage gears. The third passage takes oil to cool the meshing teeth of second stage and clutch gears and lubricate bearings No. 7 and No. 8. A fourth passage takes oil to pressurize the torquemeter chamber and lubricate accessory gearshaft bearings.

SCAVENGE OIL SYSTEM

12 The scavenge oil system for each power section includes three scavenge pumps. One pump scavenges oil from No. 3 and No. 4 bearings and the reduction gearbox input section, a second scavenges oil from No. 2 bearing, and the third scavenges oil from accessory gearbox sump to main oil tank. (See Figure 1-6-4.) All three pumps are gear-type, with a common drive shaft that also drives the main pressure pump. One scavenge pump is mounted externally on the accessory gearbox cover; the other two are mounted internally in the gearbox itself.

13 Oil from No. 1 bearing is returned by gravity to the bottom of the compressor inlet case, and from there through an internal cored passage to the accessory gearbox sump. Oil from No. 2 bearing is returned via an internal scavenge tube to the bottom of the gas generator case, and from there via an external scavenge line, the check and regulating valve block

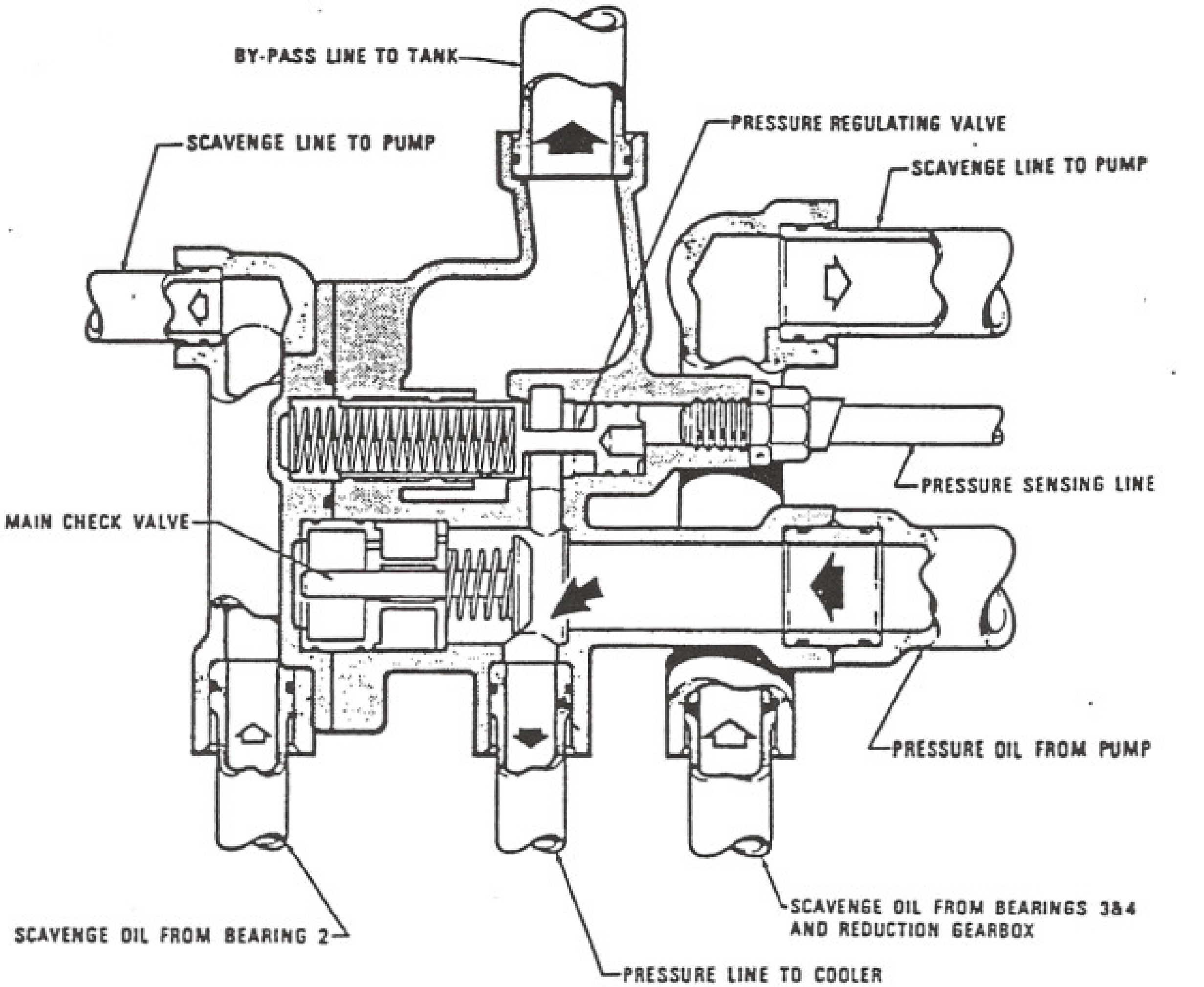

Figure 1-6-3 Check and Regulating Valve Schematic

on the accessory gearbox, and a further external scavenge line to the externally mounted scavenge pump. Oil from No. 3 and 4 bearings is returned from the reduction gearbox output housing sump area via external scavenge line, check and regulating valve block, and external and internal passages to the large internally mounted scavenge pump.

14 A ball-type valve, mounted in the pump housing provides a bypass for the externally mounted scavenge pump, and allows excess oil vapor from No. 2 bearing to bypass the pump. The pump delivers oil to the accessory gearbox sump, to be scavenged together with oil from No. 1 bearing and the accessory gearbox bearings by the smaller of the internal pumps, and returned through an internal passage to the main oil tank. The larger pump also delivers oil through the same internal passage directly to the main oil tank.

15 In addition to the three main scavenge pumps, an ejector pump boosts scavenge oil from No. 3 and 4 bearings. The pump operates on the venturi principle and utilizes pressure oil from the supply line to No. 3 and 4 bearings. The pressure oil in flowing through a restrictor nozzle (see Figure 1-6-5) in the pump housing at high velocity causes sufficient reduction in pressure at the throat area to suck the scavenge oil along the scavenge tube from the bearing area. Scavenge and pressure oil from the ejector pump are sprayed into the sump area at the bottom of the reduction gearbox input section, and scavenged from there by the scavenge pump in the accessory gearbox.

BREATHER SYSTEM

16 Breather air from power section bearing compartments and gearboxes is vented through a centrifugal breather located in the accessory gearbox. Air

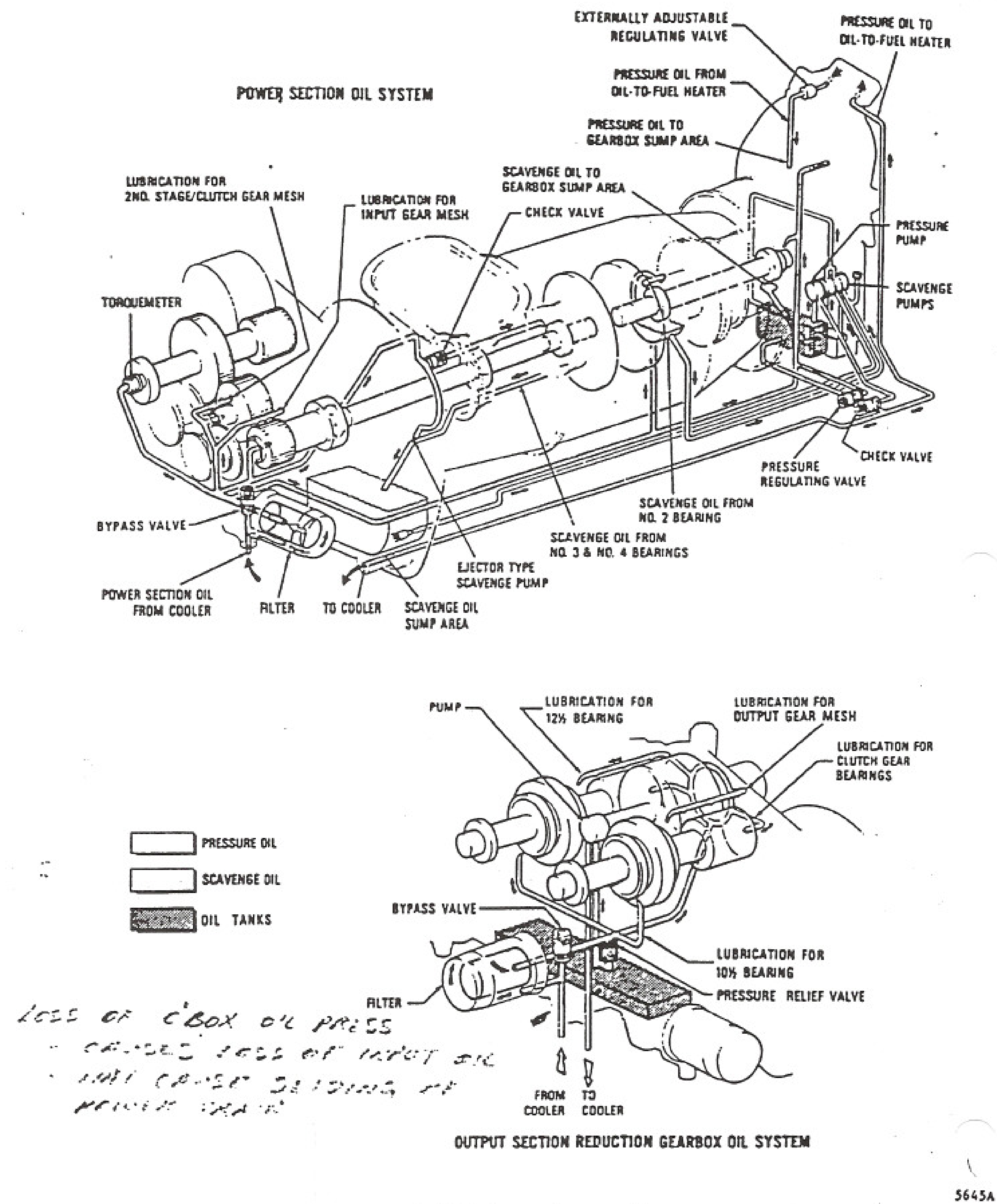

Figure 1-6-4 Lubrication Systems Schematic

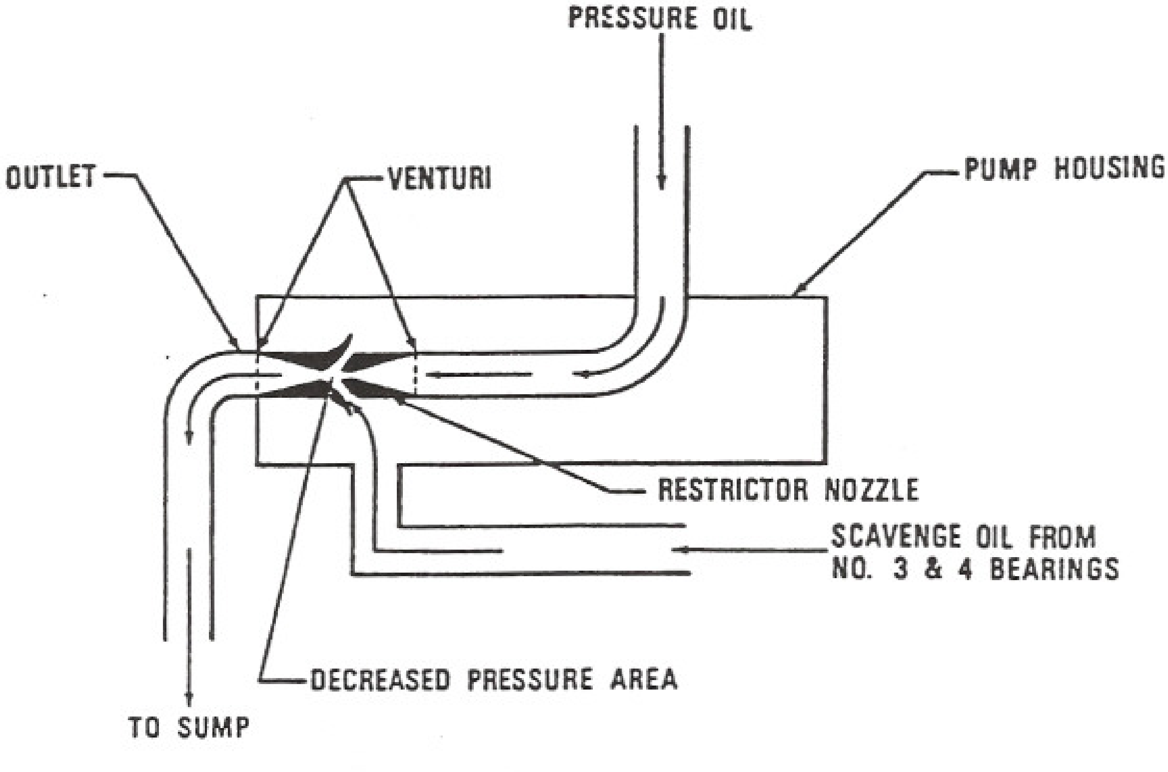

Figure 1-6-5 Ejector Pump Operation

from the main oil tank enters the gearbox through breather passages in the housing casting, and air from No. 1 bearing compartment enters with scavenge oil through the cored scavenge passage from the compressor inlet case.

CENTRIFUGAL BREATHER

17 The centrifugal breather consists of a shrouded aluminum alloy impeller located by three pins to the face of the starter-generator gear, and secured on the shaft by a retaining ring. Oil vapor in the gearbox is picked up by vanes on the rotating impeller face, and thrown outward by centrifugal force. The oil drains to the bottom of the gearbox and air vents overboard through a vent shaft in the accessory gearbox housing casting to atmosphere.

OIL-TO-FUEL HEATER

18 The oil-to-fuel heater assembly is basically a plate and fin constructed heat exchanger which utilizes heat from the power section oil to maintain fuel temperatures within a specified range. The assembly consists of collectors, heat exchanger ~~, and a valve body, which are integral with ~at exchanger. (See Figure 1-6-6.) A thermal ~ent, guide, valve sleeve, and spring are con~ained in the valve body by a retaining cap which is secured by lockwire.

19 Fuel flow through the oil-to-fuel heater passes from inlet to outlet connections via a thermal element. The element consists of a highly expansive material sealed in a metallic chamber, the expansion force being transmitted through a diaphragm and rod to the heater valve sleeve. Since the element exerts an expansive force only, it is counter-balanced by a spring which provides a force to return the sleeve when the fuel temperature decreases. When fuel temperatures decrease below 21.1°C (70°F) the sleeve valve is closed, and oil through the inlet connection flows through the heater core to increase fuel temperature. The element senses outlet fuel temperatures and, at temperatures above 21.1°C (70°F), starts to move the valve sleeve to gradually close the core exit while at the same time opening a bypass flow. At fuel outlet temperatures above 32.2°C (90°F), the core exit is fully closed forcing the entire oil flow to bypass the core.

REDUCTION GEARBOX OUTPUT SECTION OIL SYSTEM

20 A single gear-type pressure pump, driven from the engine output shaft, provides lubricating oil to output shaft bearings and two gearbox composite third stage shaft bearings (see Figure 1-6-7). Oil is drawn through an inlet screen from an oil tank formed between input and output housings and delivered to an oil cooler. Return oil from the cooler is passed through a filter identical to those in power section oil systems and delivered to bearings. A

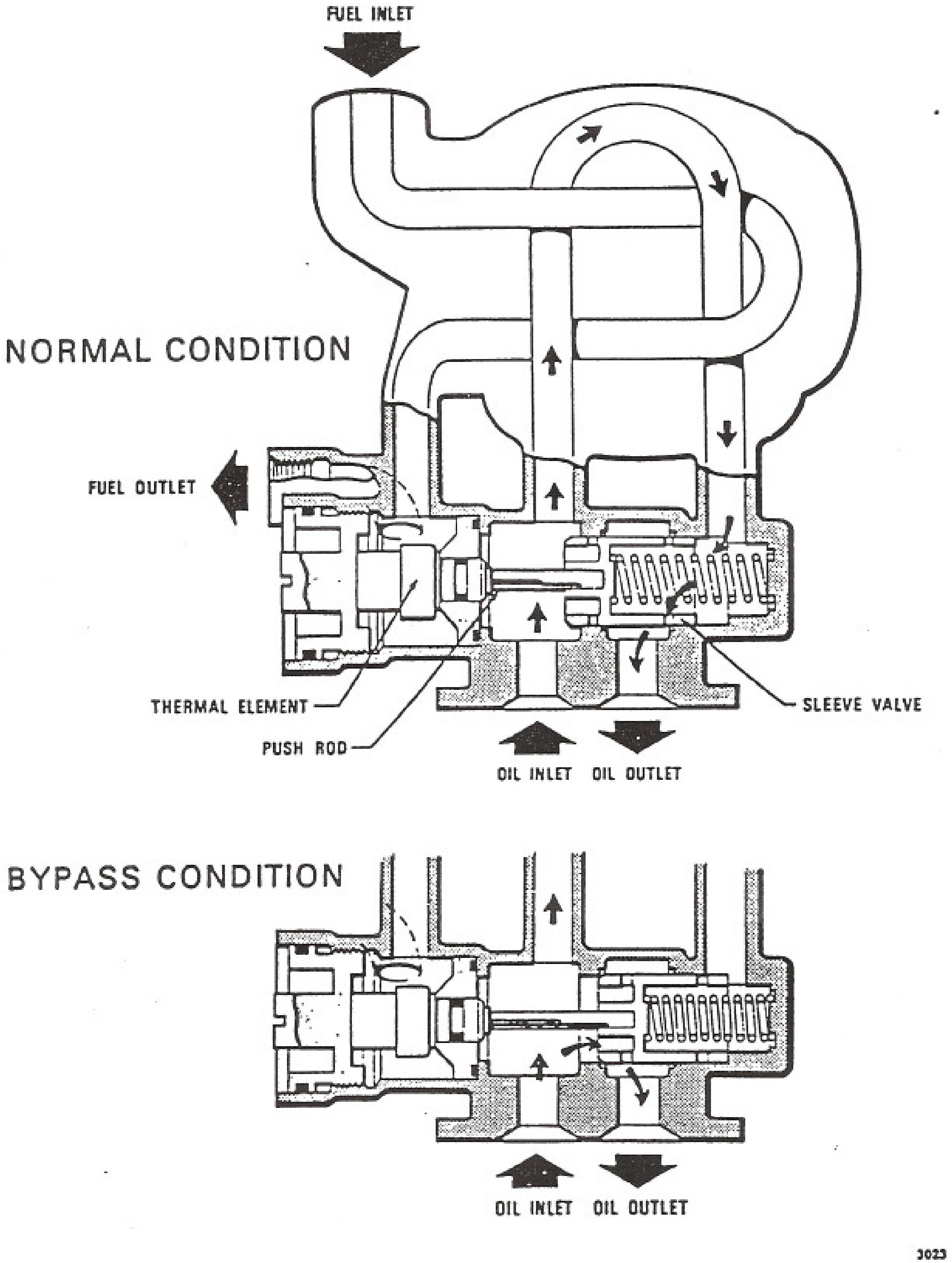

Figure 1-6-6 Oil-to-fuel Heater

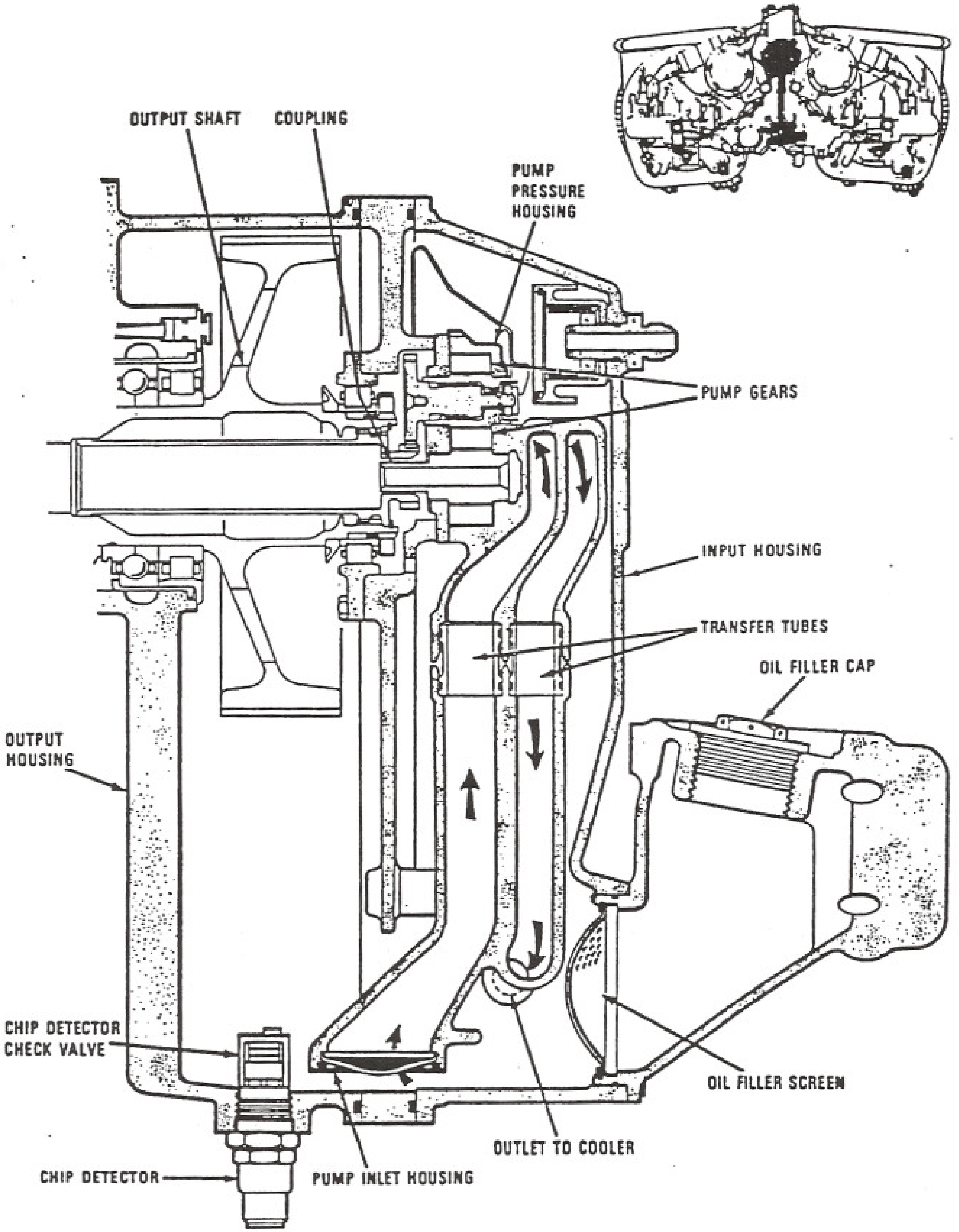

Figure 1-6-7 Reduction Gearbox Output Section Pressure Pump

spring-loaded pressure relief valve, downstream from the filter, regulates system pressure by allowing oil into the tank (Pre-SB5054) when pressure becomes excessive.

21 On engines (Post-SB5054, the oil pressure pump has wider gears and runs at a lower speed but retains the original capacity. In addition, the pressure relief valve is installed within the pump inlet housing and allows filtered pressure oil to augment pressure pump inlet flow. This feature prevents oil cavitation and reduces the risk of bearing erosion.

22 Casting passages take pressure oil from the filter to an annulus in the output housing, and an offshoot from these passages supplies cooling oil to the mesh of two reduction gearbox third stage gears and output shaft gear. Two passages from the annulus take oil to nozzles spraying inside the two No. 10 bearings under centrifugal flow, and to collect integral reservoirs of each sprag clutch. Fro. clutch reservoirs, oil flows outward to lubricate bearings No. 10-1/2, 11, 12 and 12-1/2. Two jets, fed by transfer tubes, provide additional lubrication to the No. 10-1/2 bearings (Post-SB5094). Bearings No. 13 and 14 are splash-lubricated from sprays directed onto output shaft gear meshes. Bearings No. 15, 16 and 17 are lubricated from the annulus.

23 The system relies on gravity to scavenge lubricating oil from bearings, oil returning directly to the reduction gearbox oil tank. Carbon seals mounted on the clutch gear, and pressurized by P_3 air, prevent oil entering either reduction gearbox input section. Seals are pressurized by P_3 air from whichever power section has the higher operating pressure. A breather tube in the output housing vents to atmosphere.

SECTION 7

IGNITION SYSTEM

GENERAL

1 The ignition system consists of two spark igniter systems; one for each power section. The system has been developed and adapted to provide the engine with an ignition system capable of quick light-ups over a wide temperature range. Each spark igniter system consists of an exciter box, two ignition leads and two spark igniters, and will operate from a 9 to 30 volt dc supply.

EXCITER BOX

2 The exciter box is remote-mounted. It converts dc input to high voltage dc through solid-state circuitry, a transformer and rectifiers. When the energy in a storage capacitor reaches a level equivalent to four joules, an internal spark gap in the box arcs and allows the stored energy to be discharged to the igniters through a dividing and step-up transformer network. The network is such that if one igniter is open or shorted, the remaining igniter will continue to function.

SPARK IGNITERS

3 The two spark igniters are mounted in floating housings at the 4 o'clock and 11 o'clock positions on the gas generator case, and protrude into the domed end of the combustion chamber (see Figure 1-7-1).

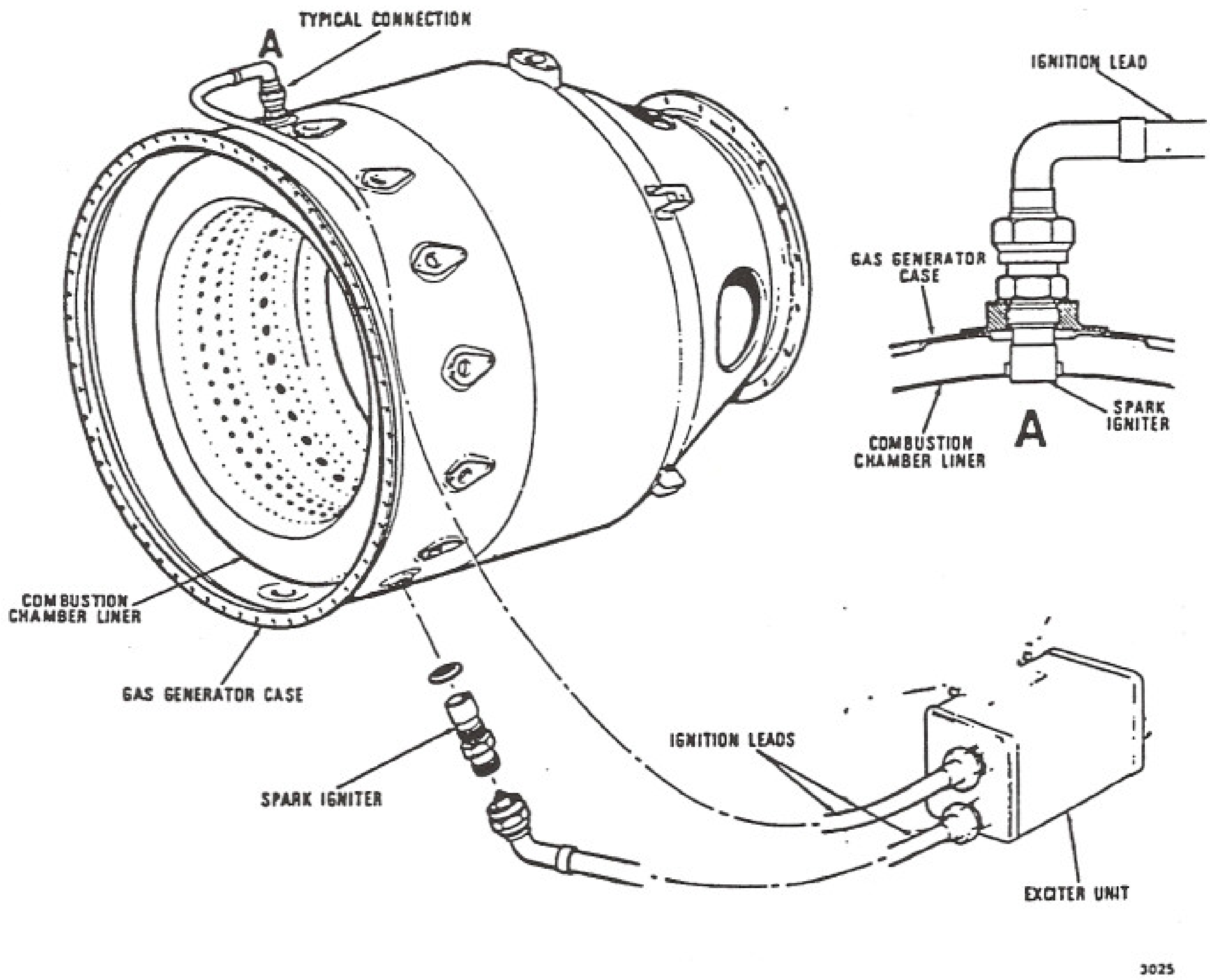

Figure 1-7-1 Ignition System - Installation

SECTION 8

FUEL SYSTEM

INTRODUCTION

GENERAL

1 The engine fuel system (see Figure 1-8-1) consists of separate identical power section fuel control systems and fuel pumps and a common torque control unit. Each power section fuel control system consists of an N_f governor, an automatic fuel control unit and a manual fuel control unit. A dual-fuel manifold and 14 simplex fuel nozzles supply fuel to the combustion chamber, and two drain valves ensure drainage of residual fluids from the gas generator case after power section shutdown.

FUEL PUMP

GENERAL

2 This is a positive displacement gear type pump, incorporating spring and fuel pressure loaded bushings, driven off the accessory gearbox. A splined coupling transmits drive to pump gears and is lubricated by oil mist from the accessory gearbox. Fuel enters the pump through a 10-micron screen and passes to the pump gear chamber. A spring-loaded, piston-type relief valve provides an alternative path for unfiltered fuel in the event of a pressure build-up caused by filter screen blockage, and two pressure taps are provided to monitor pressure upstream and downstream from the screen. Bypass fuel is returned to the pump inlet downstream from the filter via an injector pump. This non-mechanical injector pump takes the excess flow from the fuel control and transmits energy contained in the higher pressure of bypass fuel flow to pump inlet, thus raising total pressure to gear inlet and reducing vapours to a liquid allowing pump to operate at altitude without cavitating.

FUEL CONTROL SYSTEM

GENERAL

3 The fuel control system consists of four separate units with interdependent functions: an Automatic Fuel Control Unit (AFCU), a Manual Fuel Control Unit (MFCU), a N_f Governor, and a Torque Control Unit (TCU). The AFCU incorporates a compressor turbine governor and a metering valve and bellows assembly, and determines the proper fuel schedule for power section steady-state operation and acceleration. The MFCU has two operating conditions, automatic or manual, which are selected by the pilot at his discretion for individual power sections. Selection is effected by means of an electric solenoid valve. When de-energized the valve is closed giving control of fuel to the AFCU, N_f governor and torque control. When energized the solenoid valve transfers control to the MFCU over which the torque control unit and Nf governor have no effect and fuel becomes a function of power lever position only. The TCU compares and balances power section output torques and imposes a maximum limit on engine torque.

AUTOMATIC FUEL CONTROL UNIT

GENERAL

4 The AFCU is mounted on the fuel pump and driven at a speed proportional to gas generator speed. It establishes a proper fuel schedule, in response to power requirements, by controlling the speed of the gas generator through regulation of fuel flow.

FUEL SECTION

GENERAL

5 The fuel control is supplied with fuel from the fuel pump via a transfer valve in the MFCU. Fuel flow is established by a metering valve and bypass valve system, fuel at pump (P1) pressure being applied to the entrance of the metering valve. Fuel pressure immediately after the valve, metered (P2) pressure, is compared with P1 pressure b[illegible] bypass valve, and a constant differential (P1 - [illegible] is maintained. The orifice area of the metering valve changes to meet specific power section requirements, and fuel pump output in excess of those requirements is returned to the pump inlet. Returned fuel is referred to as P_0. The bypass valve consists of a sliding valve in a ported sleeve, actuated by a diaphragm and spring. In operation, spring force is balanced by $P_1 - P_2$ pressure differential working on the diaphragm.

6 The metering valve consists of a contoured needle working in a sleeve, so that needle movement changes the valve orifice area. The bypass valve maintains an essentially constant differential fuel pressure across the orifice, regardless of variations in fuel inlet and discharge pressures. Fuel flow is thus a function of orifice area, and consequently is controlled solely by metering valve position.

7 Compensation for variations in specific gravity of the fuel, caused by fuel temperature changes, is provided by a bi-metallic disk under the bypass valve spring. An external adjustment above the bypass valve is provided to adjust acceleration rate of either power section to within predetermined limits.

POWER INPUT, SPEED GOVERNOR AND ENRICHMENT SECTION

8 For details of governor and enrichment l[illegible] see Figure 1-8-2. Views A and B identify indivi[illegible]

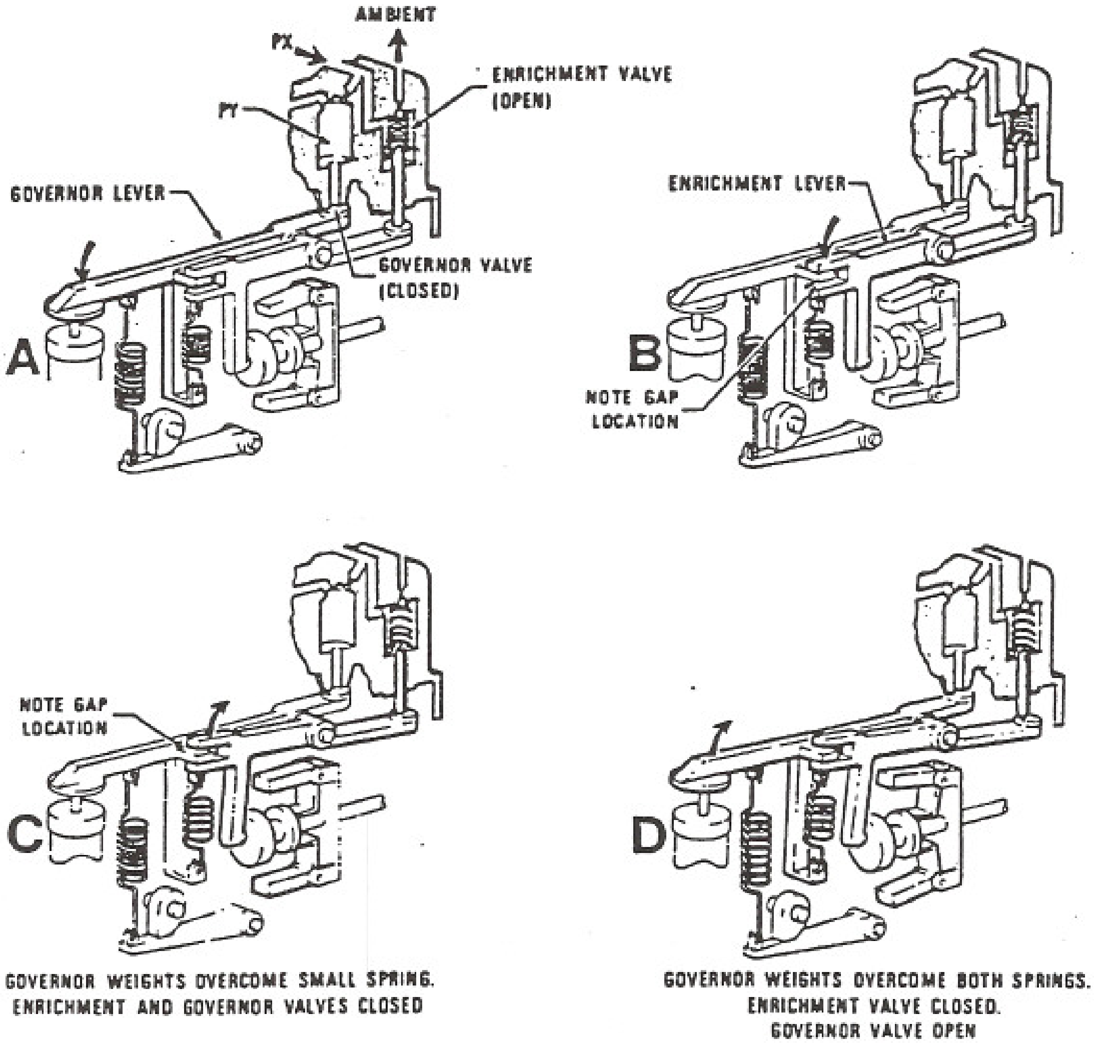

Figure 1-8-2 Power Input Speed Governor and Enrichment Levers Operation

levers and their inter-relationship. Views C and D show the levers in operation. A speed-scheduling cam depresses an internal lever to its maximum position during flight, and this cam follower lever is connected by a spring to the governor lever. The governor lever is pivoted, and a face on its free arm operates against an orifice to form the governor restrictor. An enrichment lever is pivoted at the same point as the governor lever. It has two extensions which straddle a portion of the governor lever so that after a slight movement a gap will be closed and then both levers must move together. A roller on the enrichment lever drive arm contacts the end of the governor spool, and a fluted pin on the free arm operates against a "hat" valve seating on the enrichment orifice. A small enrichment spring connects enrichment and governor levers.

9 The speed-scheduling cam applies tension to the governor lever spring when increased power is demanded, and applies a force to close the governor restrictor. The enrichment restrictor opens at the same time because enrichment spring tension ensures that enrichment lever follows governor lever. As the drive shaft assembly rotates, it turns a table on which governor weights are mounted. Small levers on the inside of the weights contact the bearing cap assembly and, as N_g increases, centrifugal force causes the weights to apply increasing force against the cap. This tends to move the cap outward on the shaft against the enrichment lever, and when this force overcomes enrichment spring tension the enrichment lever moves and the enrichment valve closes.

10 Enrichment and governor valves operate whenever N_g increases sufficiently to overcome governor spring tension, enrichment valve closing and the governor valve opening. At a point dependent on speed-scheduling cam position, governor spring tension overcomes enrichment spring tension, and the enrichment lever moves independently of the governor lever to close the enrichment valve. When the gap between straddle extensions and governor lever is taken up, governor lever and enrichment lever again move together. At this point the hat valve is fully closed. The governor valve will open if N_g force continues to increase sufficiently.

11 An air pressure regulator and governor reset section also controls movement of the governor lever. The air pressure regulator consists of a spring-loaded, diaphragm-operated valve. Compressor discharge pressure (P_3) is applied to the entrance of this valve. Spring-load and ambient air pressure are applied to one side of the regulator diaphragm causing a force to open the valve; regulated air pressure (P_r) is applied to the other side of the diaphragm causing a force to close the valve. Thus, as P_r rises, the valve closes, and vice-versa.

12 Regulated air pressure (P_r) is also applied to one side of the governor reset diaphragm and passed through the reset bleed to the other side of the diaphragm, where it is designated P_g. An external line from the reset section P_g outlet connects with the N_f governor. When the governor reset valve (orifice) is opened, there will be a flow through the reset bleed with pressure drop (P_r - P_g), and P_g will be reduced. Movement of the reset diaphragm will then cause the reset rod to apply a force to the governor lever to overcome the governor spring force and increase bleed-off of P_y.

13 The main governor body incorporates a vent port to atmosphere (P_a). Modified compressor discharge pressures, P_x and P_y, will be bled to P_a when enrichment and governor valves, respectively, are open.

BELLOWS SECTION

14 The bellows assembly contains governor bellows and evacuated acceleration bellows connected by a rod. The end of the acceleration bellows opposite the connecting rod is attached to the assembly body casting and the bellows provide an absolute pressure reference. The governor bellows are secured within the body cavity, and their function is similar to that of a diaphragm. Bellows movement is transmitted to the metering valve by a cross-shaft and associated levers. The cross-shaft moves within a torque tube, which is attached to the cross-shaft near the bellows lever. The tube is secured to the body casting by means of an adjustment bushing, and cross-shaft rotational movement is converted to torque change in the tube. The tube forms a seal between air and fuel sections of the control unit and is positioned during assembly to provide a force tending to close the metering valve. The bellows oppose this force through pressure of P_y on the outside of the governor bellows and P_x on the inside of governor bellows and outside of acceleration bellows.

15 The governor bellows are shown as a diaphragm on Figure 1-8-3. P_y is applied to one side of the diaphragm and P_x to the other. P_x is also applied to the evacuated bellows attached to the diaphragm. An area of pressure cancellation exists where P_x pressure on the acceleration bellows is cancelled by P_x pressure on the diaphragm; as a result, all pressures can be resolved into pressures acting on the diaphragm alone. These pressures are: P_y acting alone on one diaphragm surface, acceleration bellows

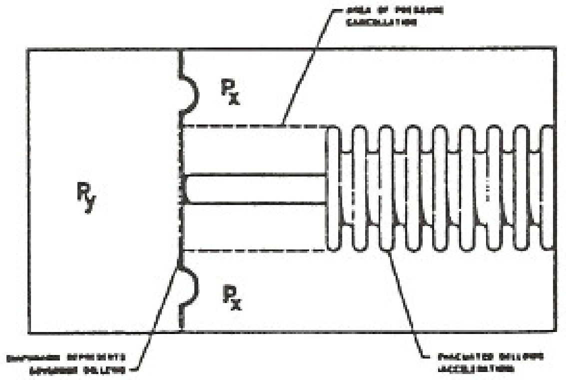

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Figure 1-8-3 Bellows Operation - Schematic internal pressure acting within the area of pressure cancellation, and P_x acting on the remainder of the diaphragm surface. A change in P_y is consequently more effective than an equal change in P_x because it acts on a larger area.

16 P_x and P_y vary with changing power section operating conditions and environment. When both increase, as during acceleration, the bellows open the metering valve. When P_y decreases, as desired N_g is approached, the bellows tend to close the metering valve. When both pressures decrease, as during deceleration, the bellows close the metering valve to its minimum flow stop.

MANUAL FUEL CONTROL UNIT

GENERAL

17 The MFCU is mounted with the AFCU on the accessory gearbox. In automatic mode it passes fuel from the pump to the AFCU, and from the AFCU to the fuel manifold and nozzles. If manual control is desired, a solenoid valve is energized to operate a transfer valve and direct fuel through the MFCU to the manifold.

SOLENOID AND TRANSFER VALVE

18 The transfer valve consists of a spring-loaded piston moving in a ported cylinder. Depending on the position of the piston, fuel is passed from an inlet port to an outlet port to the AFCU, or from the inlet port to a manually controlled metering valve. Pressures across the transfer valve piston are equalized by a piston centerbore which allows fuel to fill the space above the piston. A spring-loaded, pressure relief valve in parallel with the transfer valve allows fuel to be bypassed back to the fuel pump if inlet pressure increases.

19 The solenoid valve is spring-loaded to a closed position and seals the space above the transfer valve piston while de-energized. When electrical power is applied to the solenoid valve, it opens against spring pressure to allow fuel from the transfer valve into the bypass line. The resultant drop in pressure above the transfer valve piston causes it to move against spring pressure and block the fuel outlet port to the AFCU. At the same time, it opens a port to the MFCU metering valve.

METERING AND CUT-OFF VALVE

20 The manual throttle lever controls a combined metering and cut-off valve. A piston, mechanically linked to the manual throttle lever, controls fuel flow in the metering valve cylinder from inlet to outlet port. Space below the piston is filled with fuel from the transfer valve, and pressure of this fuel prevents piston drift from any set position. A suitable minimum fuel flow is ensured by a bypass restrictor across metering valve inlet and outlet ports which become effective when the valve approaches its minimum position.

21 The manual power lever also controls a piston in a ported cylinder which, when in the "Off" position, completely cuts off fuel flow to manifold and nozzles. There are two inlet ports to the cylinder, one from the AFCU and one from the manual metering valve. In each line to the cylinder is a check valve, and back pressure ensures that the inoperative system is sealed off. In the "Off" position, fuel reaching the cylinder is directed to a bypass line.

PRESSURIZING AND BYPASS VALVES

22 A pressurizing valve in the line from cut-off valve to manifold ensures that no fuel flows to the manifold until a pre-set minimum pressure has been attained. A diaphragm bypass valve, similar to the one in the AFCU, controls bypass fuel flow to maintain $P_1 - P_2$ constant.

PRESSURE REGULATING VALVE

22A A pressure regulating valve (see Figure 1-8-3A) is installed between the automatic and manual fuel control units to ensure that servo pressure is always available to effect transfer to manual control.

22B Fuel pressure (P1) from the MFCU transfer valve is applied to one side of the regulating valve (6) through P1 inlet. Force from valve spring (4) and fuel bypass pressure Po is applied to the other side of the regulating valve. When the fuel pressure differential P1-Po reaches 100 to 120 psig, the regulating valve moves and allows fuel to flow through holes in the sleeve (7) and passages in the valve body (9) to the P1 outlet port. This ensures that fuel pressure P1, upstream at the regulating valve is at least 100 psig above Po.

FLOW DIVIDER AND DUMP VALVE ASSEMBLY

GENERAL

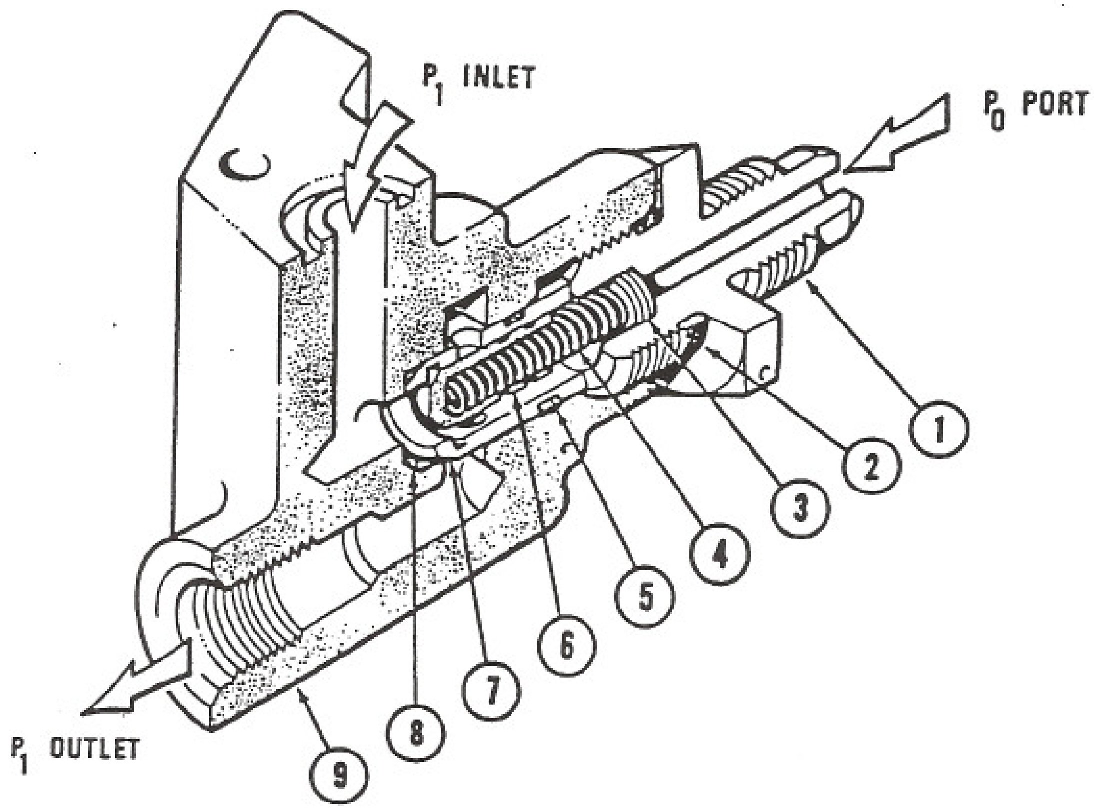
23 The flow divider and dump valve receives metered fuel from the MFCU and delivers it to primary and secondary manifolds. Initially, fuel enters the unit and exerts sufficient pressure on the divider cylinder composite piston to allow fuel flow to the primary manifold. When pressure has built up sufficiently, the inner piston is pushed back against spring pressure to allow fuel flow to the secondary manifold. (See Figure 1-8-4.) This way, a cool start is ensured by igniting initially on seven nozzles only.

24 When fuel is cut off from the unit, the composite piston moves under spring pressure to block the inlet and allows fuel in primary and secondary manifolds to drain through the dump outlet.

SURGE DAMPENER

GENERAL

25 To eliminate any possibility of power surge during fuel control system transfer from automatic to



1 Fitting
2 Preformed Packing
3 Shims
4 Spring
5 Preformed Packing
6 Regulating Valve
7 Sleeve
8 Preformed Packing
9 Valve Body

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Figure 1-8-3A Pressure Regulating Valve

manual mode, a surge dampener is connected to the fuel delivery line to the flow divider. The surge dampener is basically a piston which balances fuel pressure against the pressure of a compressed spring. Sudden increases in fuel pressure are prevented from reaching the flow divider and dump valve assembly by the action of the piston, which retracts to absorb pressure increases.

N_f GOVERNOR

GENERAL

26 The power turbine governor of each power section fuel control system is mounted on the appropriate side of the reduction gearbox and is driven at a speed proportional to the power turbine (N_f). It

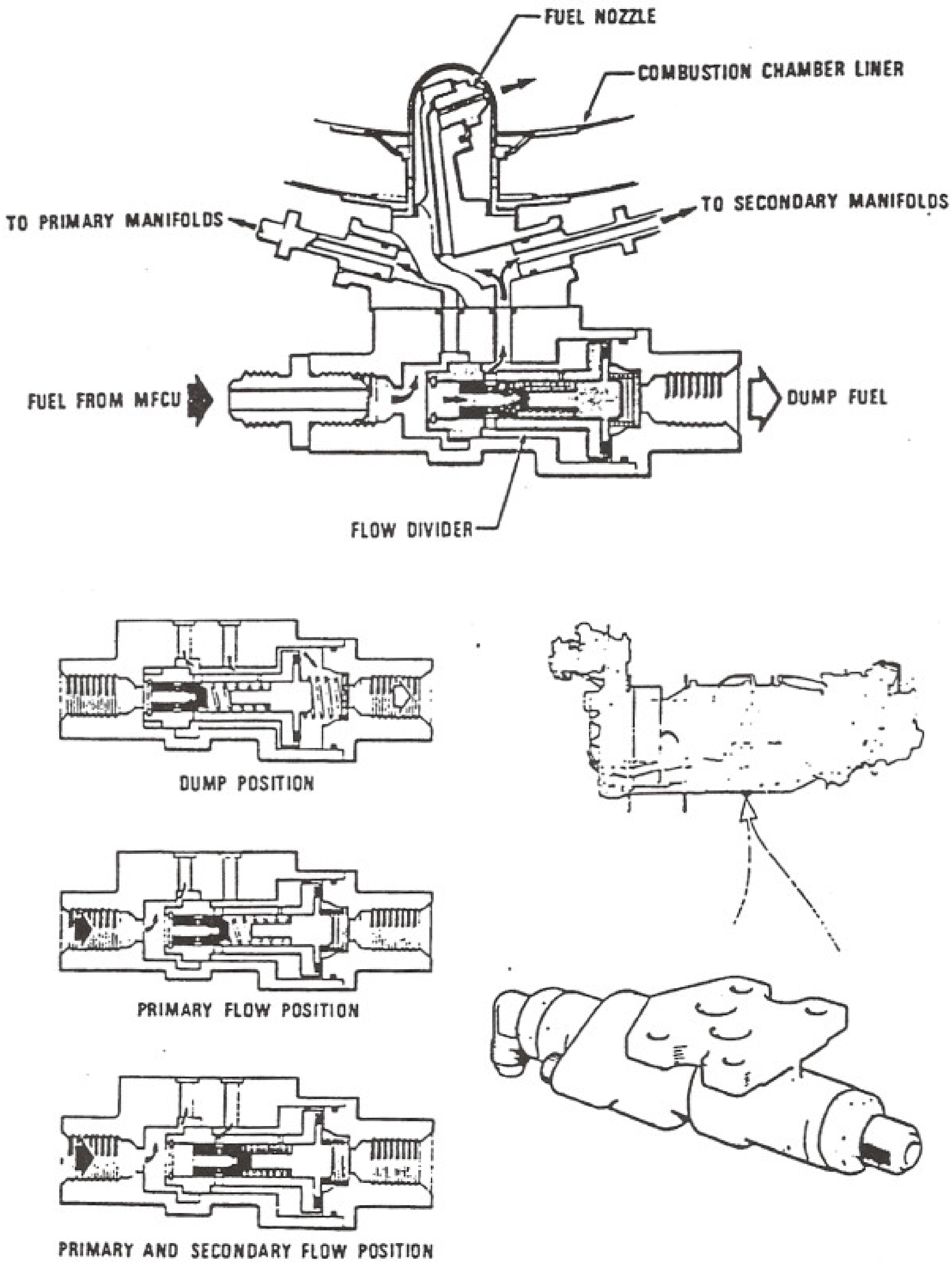

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Figure 1-8-4 Flow Divider, Inlet Manifold and Dump Valve - Schematic supplies a signal to the AFCU to change compressor speed whenever it senses a power turbine load change, and employs a drive body similar to that of the AFCU. A difference is the elimination of the enrichment mechanism. Normally, the N_f governor lever positions the governor so as to fully close the governor valve. Any tendency of the N_f to change load or speed results in the governor valve bleeding off more or less P_g. If N_f overspeeds, the valve bleeds off more P_g, and the P_r - P_g differential increases causing the governor reset rod to increase its force on the AFCU governor lever to lower P_y and reduce fuel flow. The reverse sequence would occur if N_f were caused to underspeed.

TORQUE CONTROL UNIT

GENERAL

27 A single torque control unit, mounted on the reduction gearbox, receives torquemeter oil pressure signals proportional to the torque outputs of the two power sections. By varying P_g in each power section fuel control system, the torque control unit limits engine torque output and maintains power section torque outputs equal.

28 Engine torque is limited by sensing torquemeter pressures from the two power sections and adding them in two summing bellows. At a specific total, normally closed pneumatic orifices are opened to lower P_g in both power sections, and fuel flow reduces.

29 Power section torques are equalized by means of opposed bellows which sense any difference in torques, and move a lever to restrict one of two normally open pneumatic orifices. Each pneumatic orifice vents P_g from its power section fuel control system, and closing an orifice results in increased P_g in that power section and consequent fuel flow increase. In the null position torques are equalized.

SECTION 9

ENGINE CONTROLS AND INSTRUMENTATION

GENERAL

1 The following instrumentation and controls are available and considered necessary for satisfactory PT6T-3 operation in flight, to ascertain engine mechanical condition, and to ground check and adjust engine power output.

POWER CONTROL LEVER

2 Manual and automatic fuel control units on each power section are mechanically interconnected and linked to pilot-operated airframe controls. A lever on each manual fuel control unit has 90° angular movement, and a lever on the associated automatic fuel control unit is slaved to it. At start, levers are moved from their minimum stops, which correspond to no-fuel flow, to a no-load position through 50° approximately. In flight, levers are normally set to their 90° fully-open positions. If manual engine control is selected, levers are moved within the 50° to 90° range until shutdown.

INTERTURBINE TEMPERATURE SENSING SYSTEM (T_{t5})

3 Interturbine temperature-sensing systems are designed to provide continuous indications of average operating temperatures of the gas path between compressor turbine and power turbine.

3A On Pre-SB5118 engines, each system consists of shielded leads and bus bars, and 10 chromel-alumel thermocouple probes connected in parallel across the bus bars. Each probe protrudes through a threaded boss in the power turbine stator housing, into an area adjacent to the power turbine vanes leading edge. The probe is secured to its boss by means of a floating threaded fitting which is part of the probe assembly. Shielded leads connect each bus bar assembly to a terminal block which provides a connecting point for external leads to an instrument. The terminal block is located at the 10 o'clock position on the gas generator case. Leads from bus bars are supported by brackets on the stator housing and exhaust duct. Alumel terminals are marked A/L, and chromel terminals, C/R. To ensure correct connection, terminal screws are of different sizes.

3B On Post-SB5118 engines, each system consists of an integral wiring harness incorporating eight chromel-alumel thermocouple probes connected in parallel and a terminal block. The harness is encased in a steel tube and is connected directly to each probe and the terminal block. Each probe protrudes through a threaded boss on the power turbine stator housing, into an area adjacent to the power turbine vanes leading edge. The probe is secured to the boss by means of a floating, threaded fitting which is part of the sensing system assembly. The terminal block is bolted to the gas generator case. Alumel and chromel terminals are marked A/L and C/R, respectively. To ensure correct connection, the chromel terminal block connection nut is smaller diameter than the alumel.

3C To standardize readouts, a T_{t5} temperature compensator unit is connected to the terminal block, in parallel with the T_{t5} harness. Its function is to compensate for variations in power sections, in the relationship between measured and calculated T_{t5}, and its setting is determined on engine test.

OIL PRESSURE AND TEMPERATURE INDICATORS

4 Airframe supplied oil pressure and temperature transducers are installed on the engine to monitor power section and reduction gearbox oil systems. Power section oil pressure and temperature are sensed by a transducer in the pressure oil return line in the accessory gearbox. Reduction gearbox output section oil pressure is sensed by a transducer above the output shaft in the pressure oil annulus surrounding the shaft. Oil temperatures are sensed by airframe supplied thermocouple probes in accessory and reduction gearboxes.

N_f GOVERNOR LEVER

5 The N_f governor lever can be moved between pre-set maximum and minimum stops on the governor, to control power turbine speed. Power turbine speed demand is normally held constant, and output torque varied by changing rotor pitch.

TACHOMETER-GENERATORS

6 Four airframe supplied tachometer-generators generate electric signals proportional to power section gas generator and power turbine rpm. A tachometer-generator can be mounted next to each manual fuel control unit on accessory gearboxes, and next to each power turbine governor on the reduction gearbox. The electrical signal from each tachometer-generator is applied to a tachometer to produce an rpm readout in percent.

TORQUEMETERS

7 A torque-indicating system, consisting of a torquemeter and an airframe supplied calibrated torque pressure transmitter, provides indication of each power section output torque. The torquemeter develops an oil pressure dependent on its power section output torque. This pressure and the reduction gearbox internal pressure are applied to the transmitter to provide a read-out of differential pressure on an airframe gage.

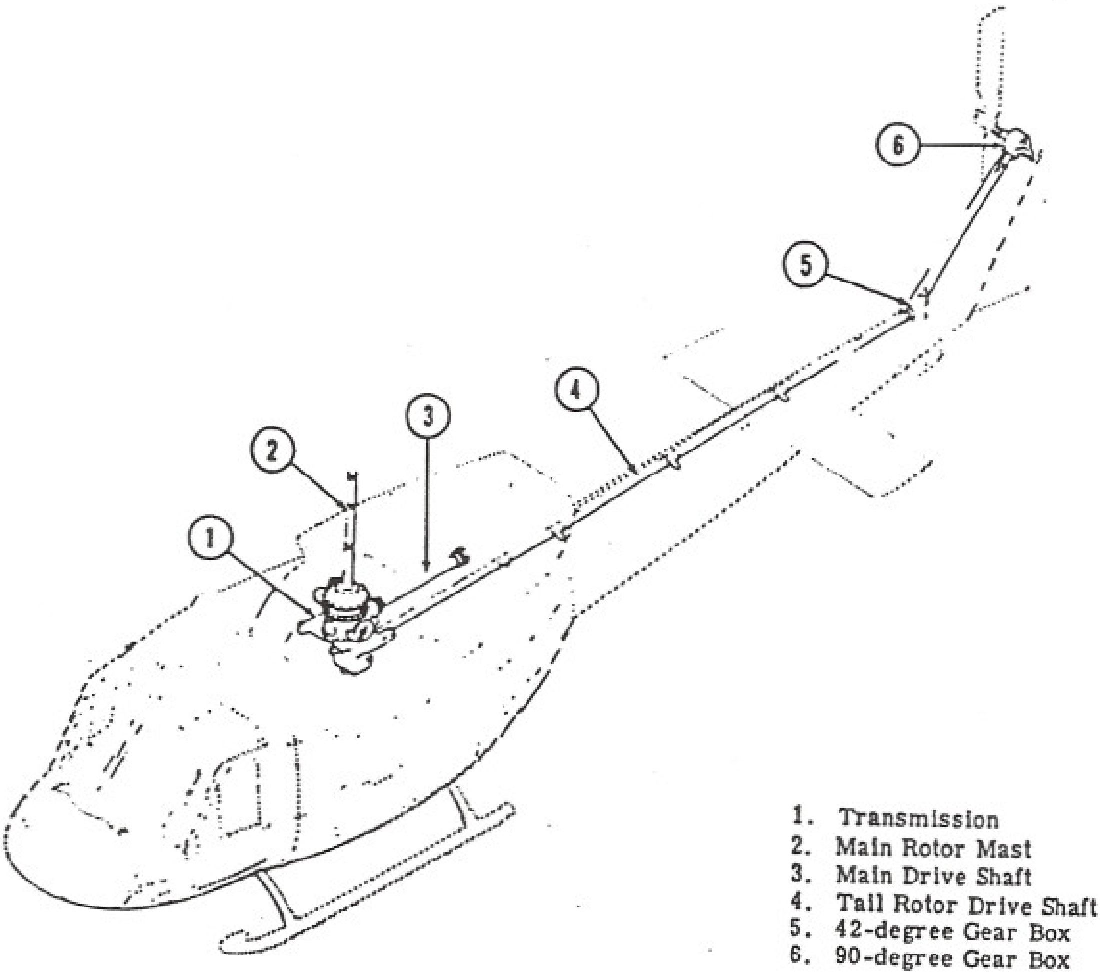
8 Both torquemeters in the reduction gearbox are individually calibrated at engine test and an associated index number is established for each and stamped on the reduction gearbox plate. When each airframe supplied calibrated torque pressure transmitter is installed on the reduction gearbox it must be adjusted to the associated torquemeter index number.

9 Transmission of drive from third stage to output shaft through helical gears results in axial movement of the clutch drive shaft in response to torque changes. (See Figure 1-4-10.). Axial movement is transmitted through No. 10 ball bearing to the torquemeter piston and piston cover, and thence to the torquemeter valve. An increase in torque moves the torquemeter valve inward in its sleeve and increases the coincidence of ports in (inlet) sleeve and valve. Oil flow into the torquemeter chamber is thus increased and pressure raised to a corresponding higher value. Conversely, when torque decreases the ports become less coincident and oil flow decreases. A constant bleed of oil from the torquemeter chamber ensures that no hydraulic lock occurs.

POWERTRAIN SYSTEM

GENERAL

The power train is a system of drive shafts and gear boxes which transmits power from the engine assembly to the main rotor and tail rotor, and to transmission-mounted accessories. Principal components are the main drive shaft, the transmission, the main rotor mast, and the tail rotor drive shaft installation which includes a series of drive shafts, bearing hangers, and two gear boxes.



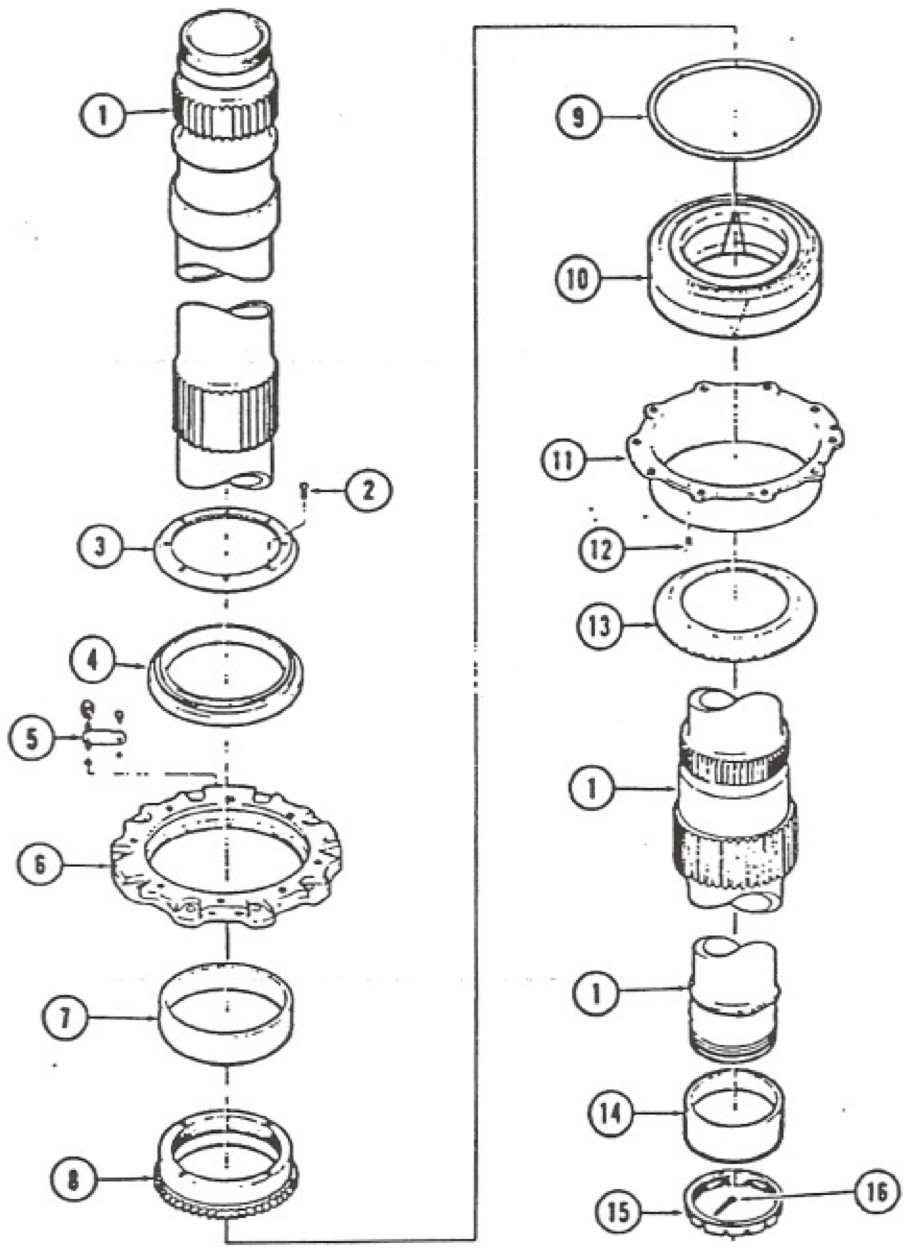
Power Train

MAST AND MAIN ROTOR CONTROLS

The main rotor mast is a tubular steel shaft supported vertically in the transmission by bearings. The upper bearing assembly is a duplex dual thrust ball type and the lower bearing inner race mates to a roller alignment bearing in the transmission. The mast, splined to and driven by the transmission's mast driving adapter, rotates counterclockwise as viewed from above. Splines on the upper portion of the mast serve to mount and drive the main rotor and control assemblies.

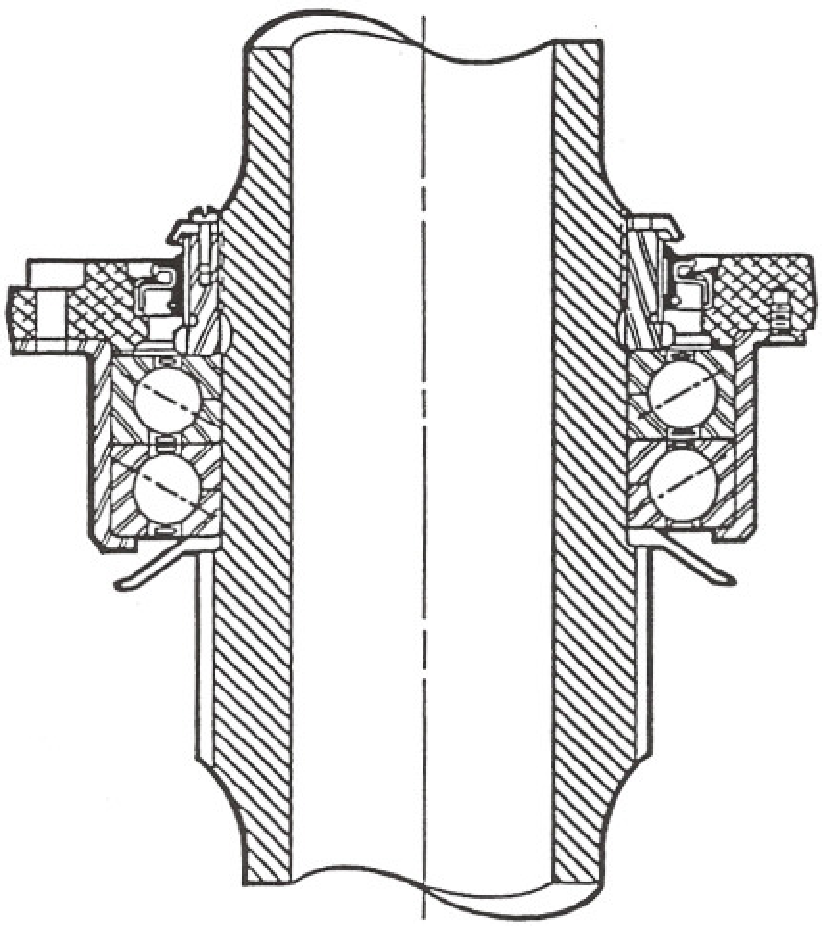
Bell

MAST ASSEMBLY — DISASSEMBLED VIEW

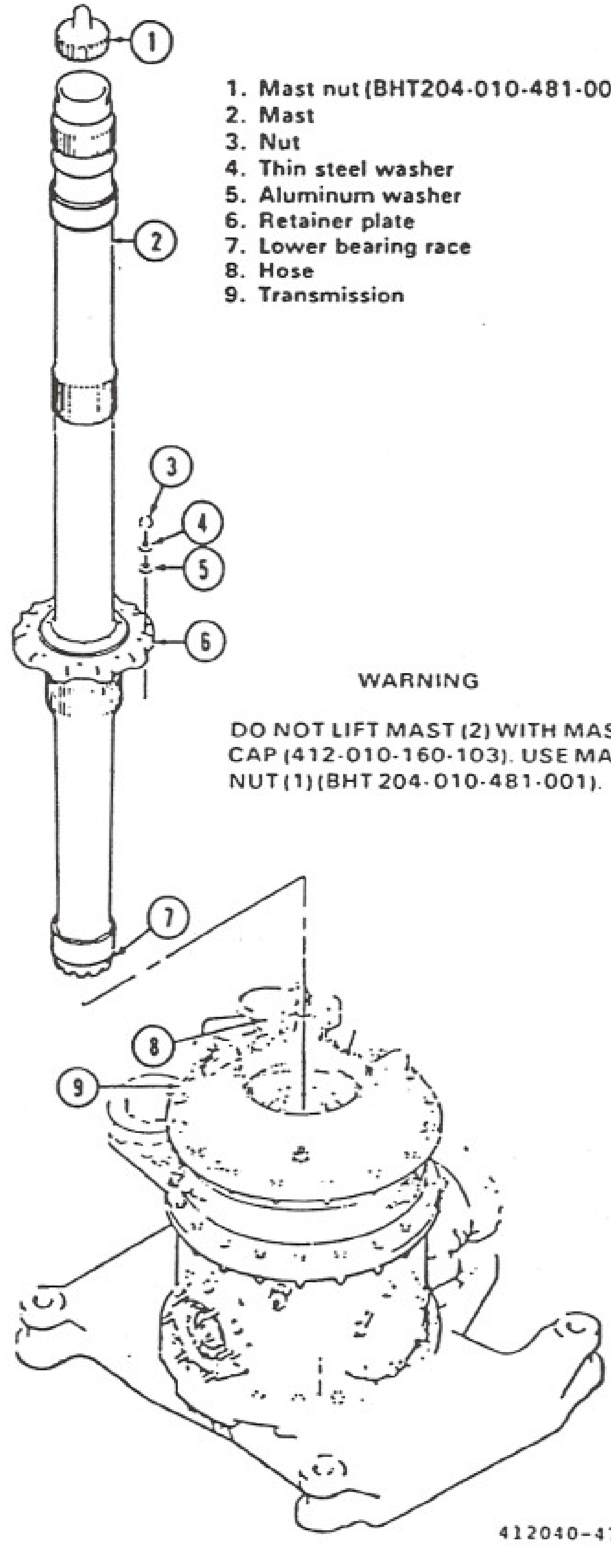


1. Mast
2. Screw (4)
3. Lock ring
4. Seal
5. Oil jet No. 8
6. Plate assembly
7. Wear sleeve
8. Retaining nut
9. Shim
10. Duplex thrust bearing
11. Bearing liner
12. Screw (4)
13. Oil slinger
14. Bearing inner race
15. Retaining nut
16. Cotter pin (2)

MAST BEARING INSTALLATION CROSS SECTION



MAST ASSEMBLY INSTALLATION



1. Mast nut (BHT204-010-481-001)
2. Mast
3. Nut
4. Thin steel washer
5. Aluminum washer
6. Retainer plate
7. Lower bearing race
8. Hose
9. Transmission

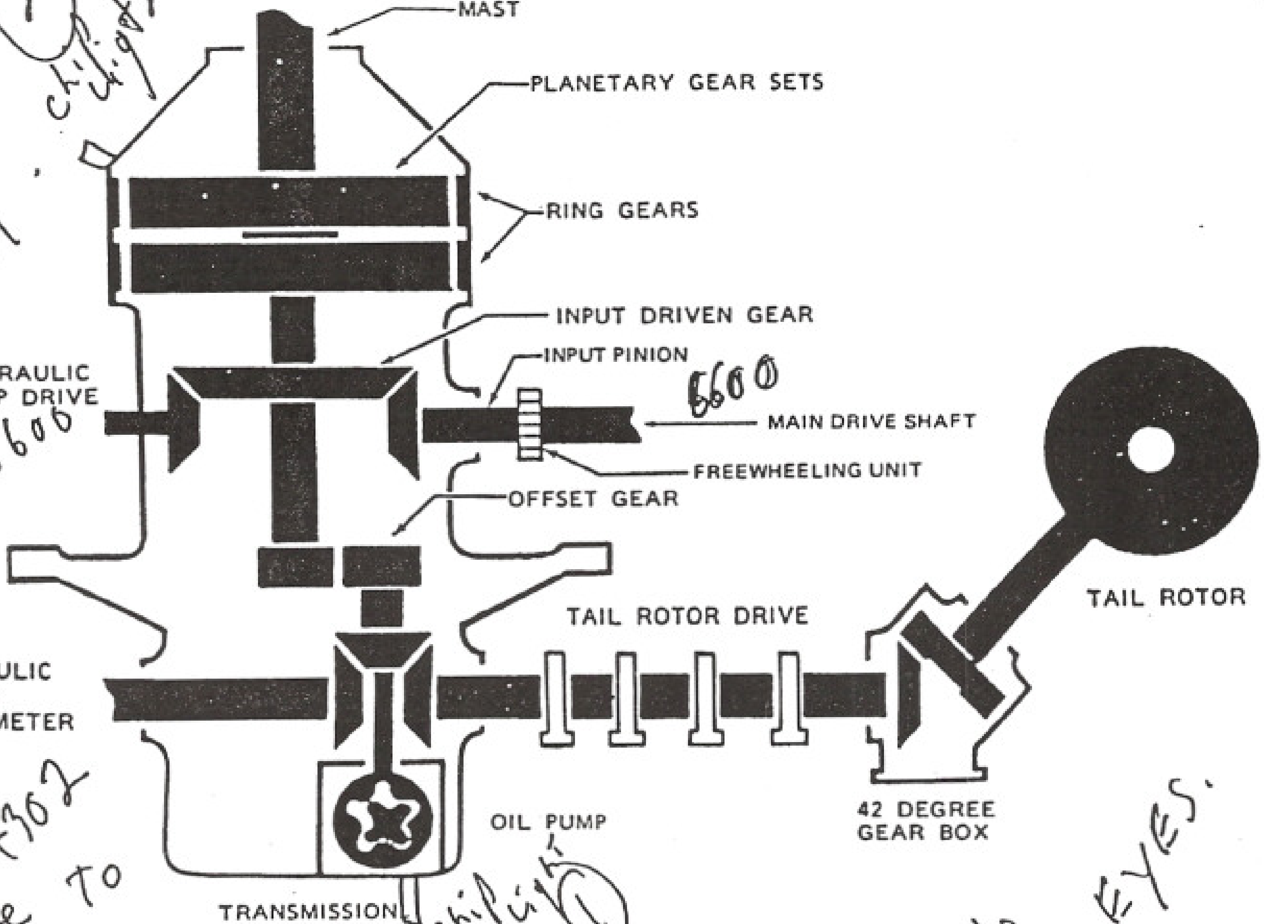
WARNING

DO NOT LIFT MAST (2) WITH MAST CAP (412-010-160-103). USE MAST NUT (1) (BHT 204-010-481-001).

412040-47

TRANSMISSION AND MAIN DRIVESHAFT

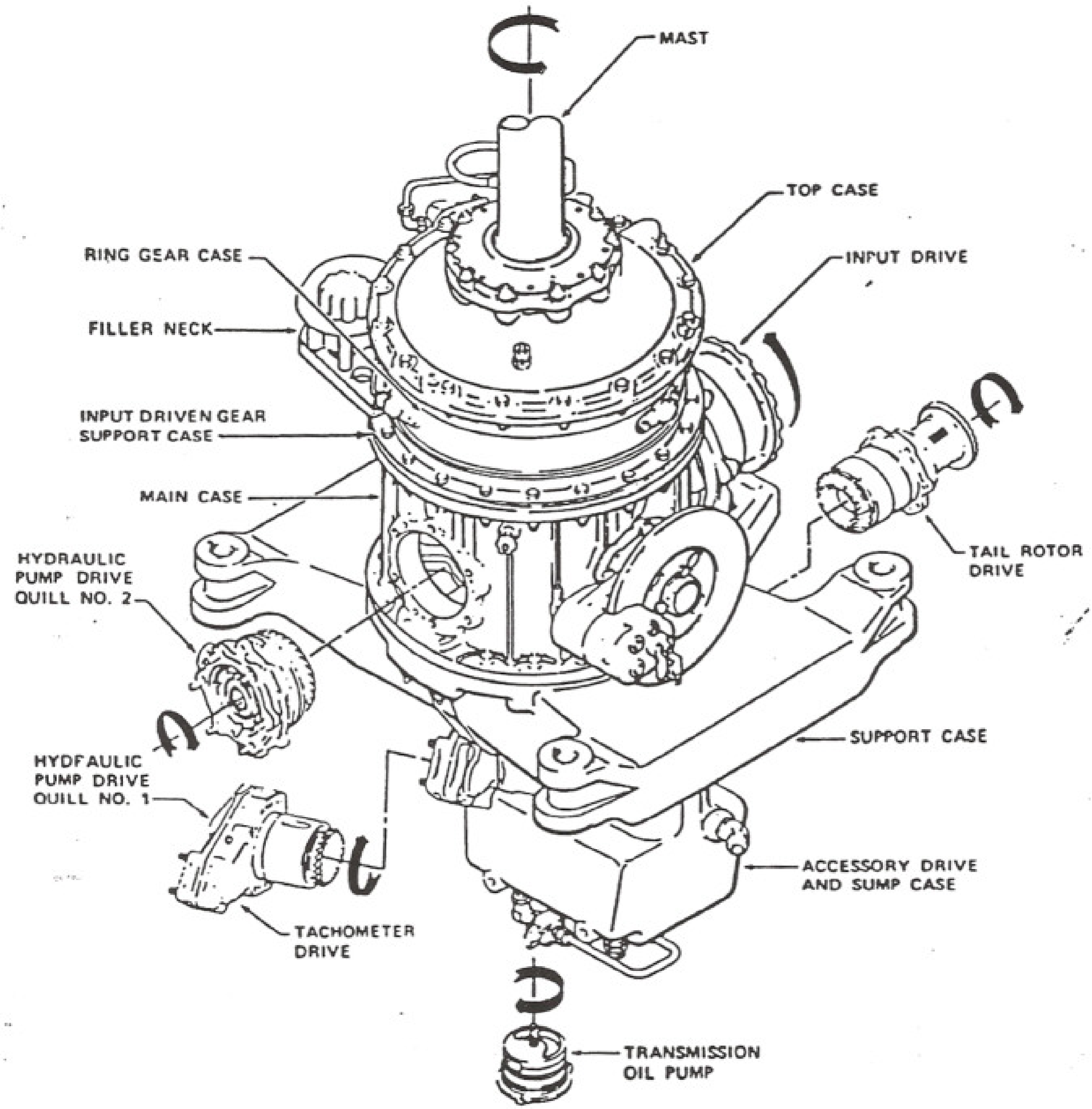
The transmission is located directly forward of the powerplant and is supported by isolation mounts attached to the fuselage pylon structure. The transmission is connected to and driven by the powerplant through a main driveshaft. The transmission provides a drive angle change, a speed reduction, drives transmission mounted accessories and drives the anti-torque system. Three gear stages provide a total speed reduction of 20.38:1 to drive the main rotor 324 RPM at 100% rotor speed. Transmission driven accessories include a rotor tachometer generator, two hydraulic pumps, an oil pump and the rotor brake quill/disc if installed.



Power Train Schematic

Notes

TRANSMISSION COMPONENTS

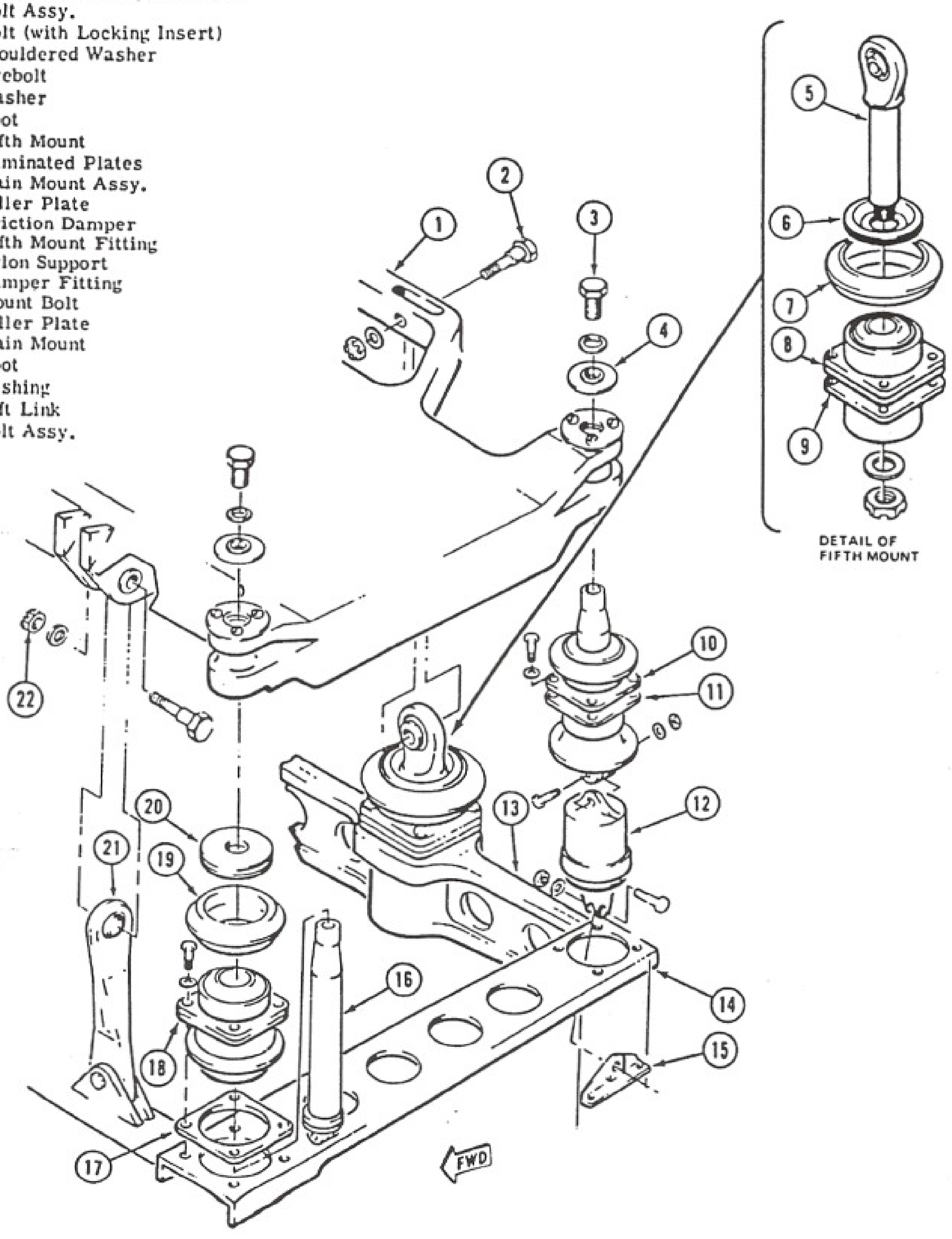


COMPONENT RPM AT 100% N-2 ENGINE RPM

Engine Output Shaft	6600 RPM
Rotor Brake Disc	8322 RPM
Hydraulic Pump #2	6600 RPM
Hydraulic Pump #1	4300 RPM
Tachometer Generator	4300 RPM
Tail Rotor Drive Shaft	4300 RPM
Oil Pump	4498 RPM
Main Rotor Mast	324 RPM

Bell

1. Transmission Support Case
2. Bolt Assy.
3. Bolt (with Locking Insert)
4. Shouldered Washer
5. Eyebolt
6. Washer
7. Boot
8. Fifth Mount
9. Laminated Plates
10. Main Mount Assy.
11. Filler Plate
12. Friction Damper
13. Fifth Mount Fitting
14. Pylon Support
15. Damper Fitting
16. Mount Bolt
17. Filler Plate
18. Main Mount
19. Boot
20. Bushing
21. Lift Link
22. Bolt Assy.



Transmission Pylon Mounts

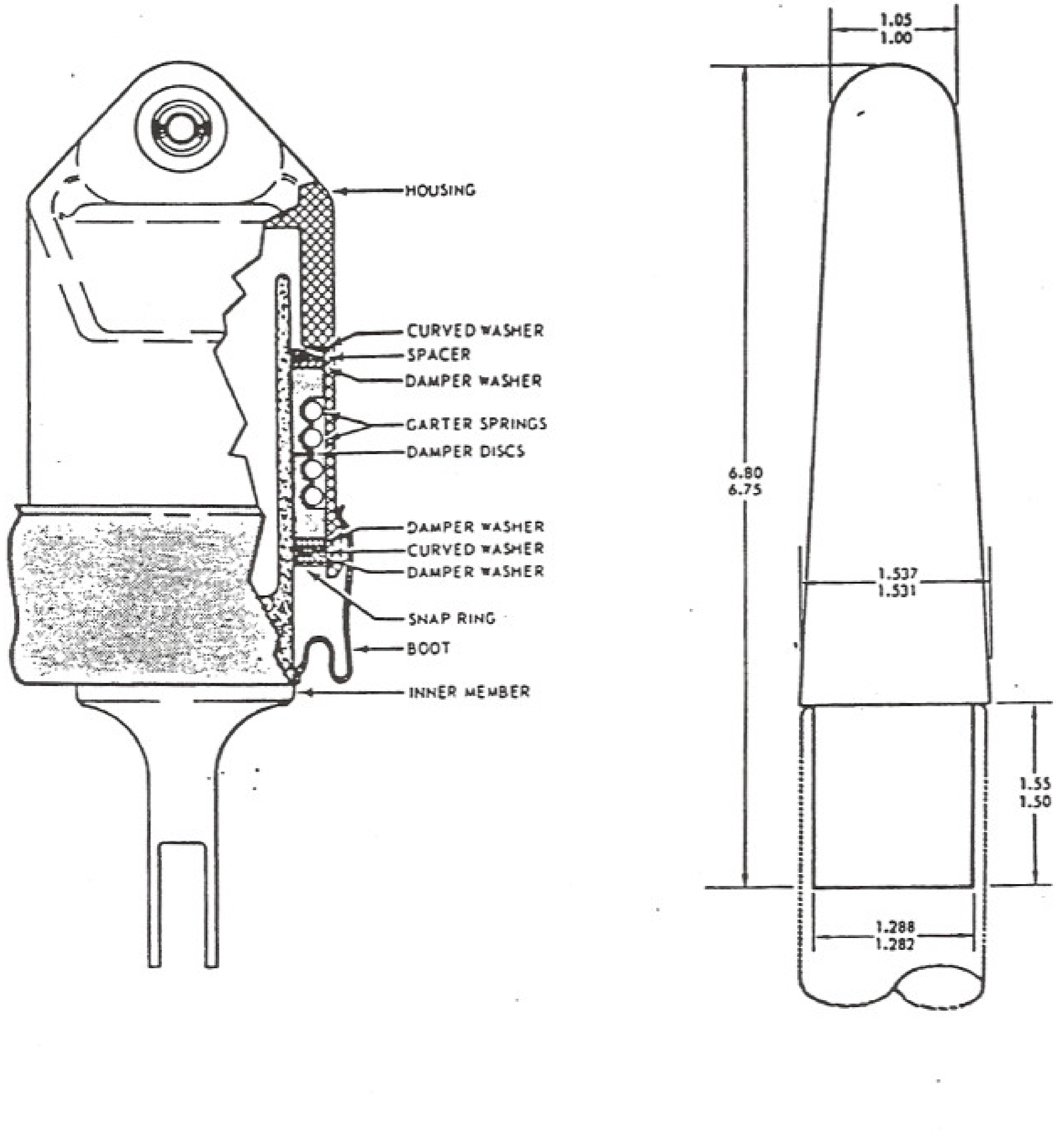
TRANSMISSION MOUNTS

A lift link and four pylon isolation mounts are used to attach the transmission to the fuselage. The forged steel lift link has self aligning bearings at each end and is connected between a steel fitting on the forward underside of the transmission support case and the fuselage lift beam directly below. The four isolation mounts are secured to the pylon structure and are attached to the corners of the transmission support case. Each mount consists of a cylindrical molded rubber core bonded between steel inner and outer sleeves, with the outer sleeve flange secured to the pylon structure by four bolts. A large bolt extends up through the mount inner sleeve to seat in a tapered bushing in the transmission support case corner arm and is secured by a retaining bolt installed from the top through a large special washer and threaded into the tapped end of the mount bolt. Silicone rubber protection boots, with supporting bushings, cover the ends of the mount. Both rear pylon isolation mounts are restrained by friction dampers, which are cylindrical units connected between the lower ends of the mount bolts and fittings in the pylon support structure.

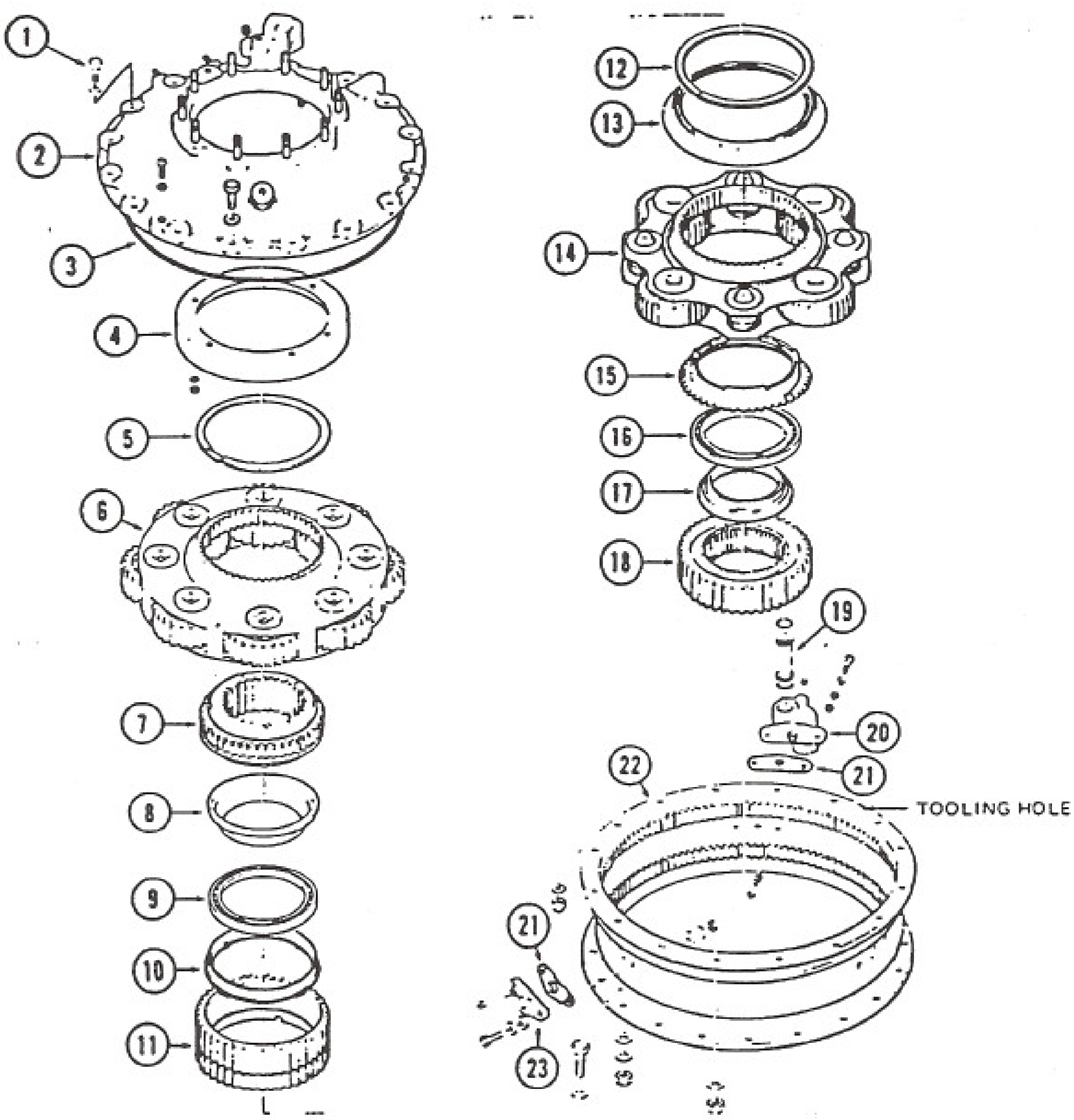
Bell

PYLON MOUNT DAMPER WITH REASSEMBLY TOOL

NOTE: MAKE FROM ROUND STOCK 9 IN. LG. X 1-3/4 IN. DIA. POLISH TAPERED SURFACE TO ALLOW EASIER INSTALLATION OF GARTER SPRINGS

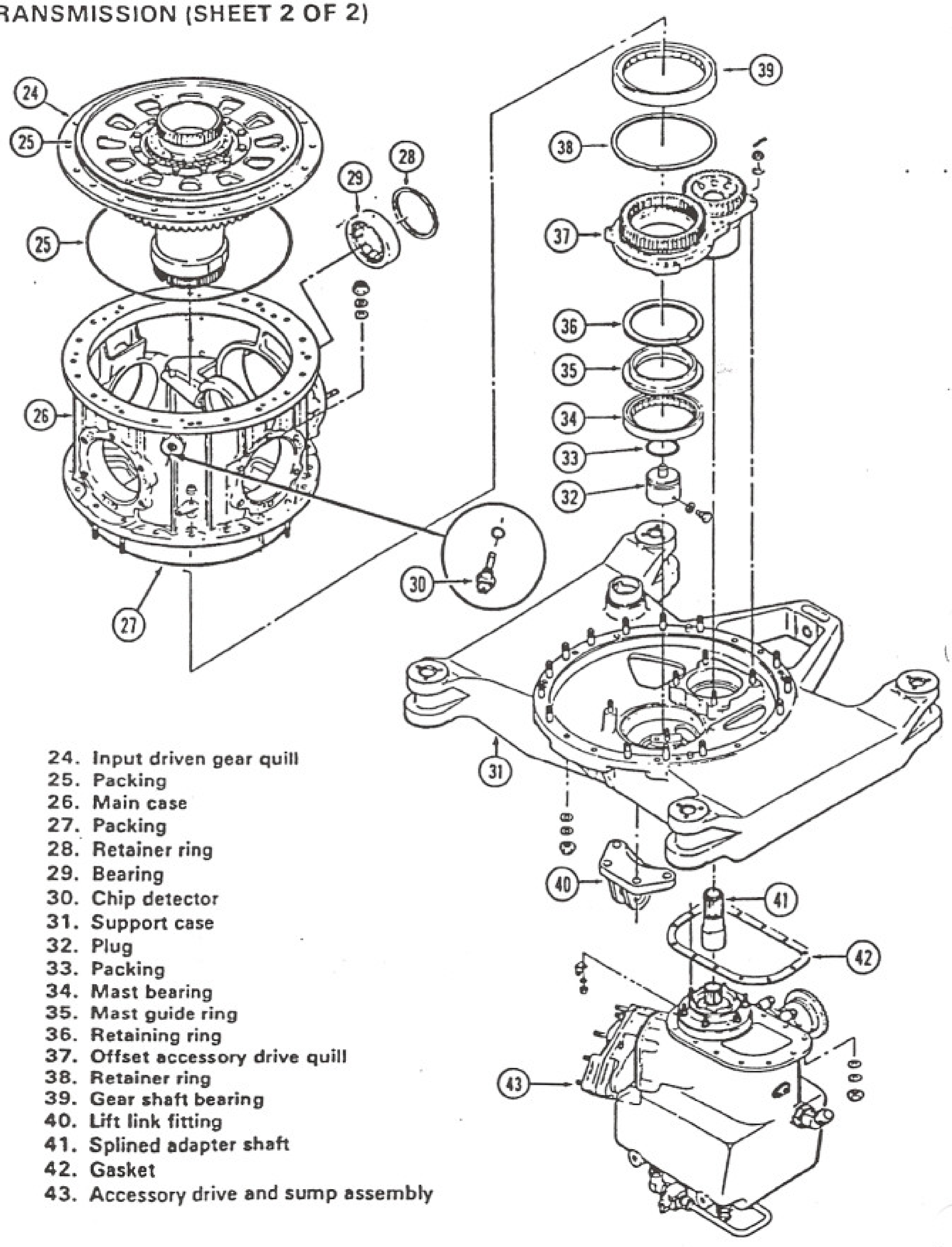


TRANSMISSION



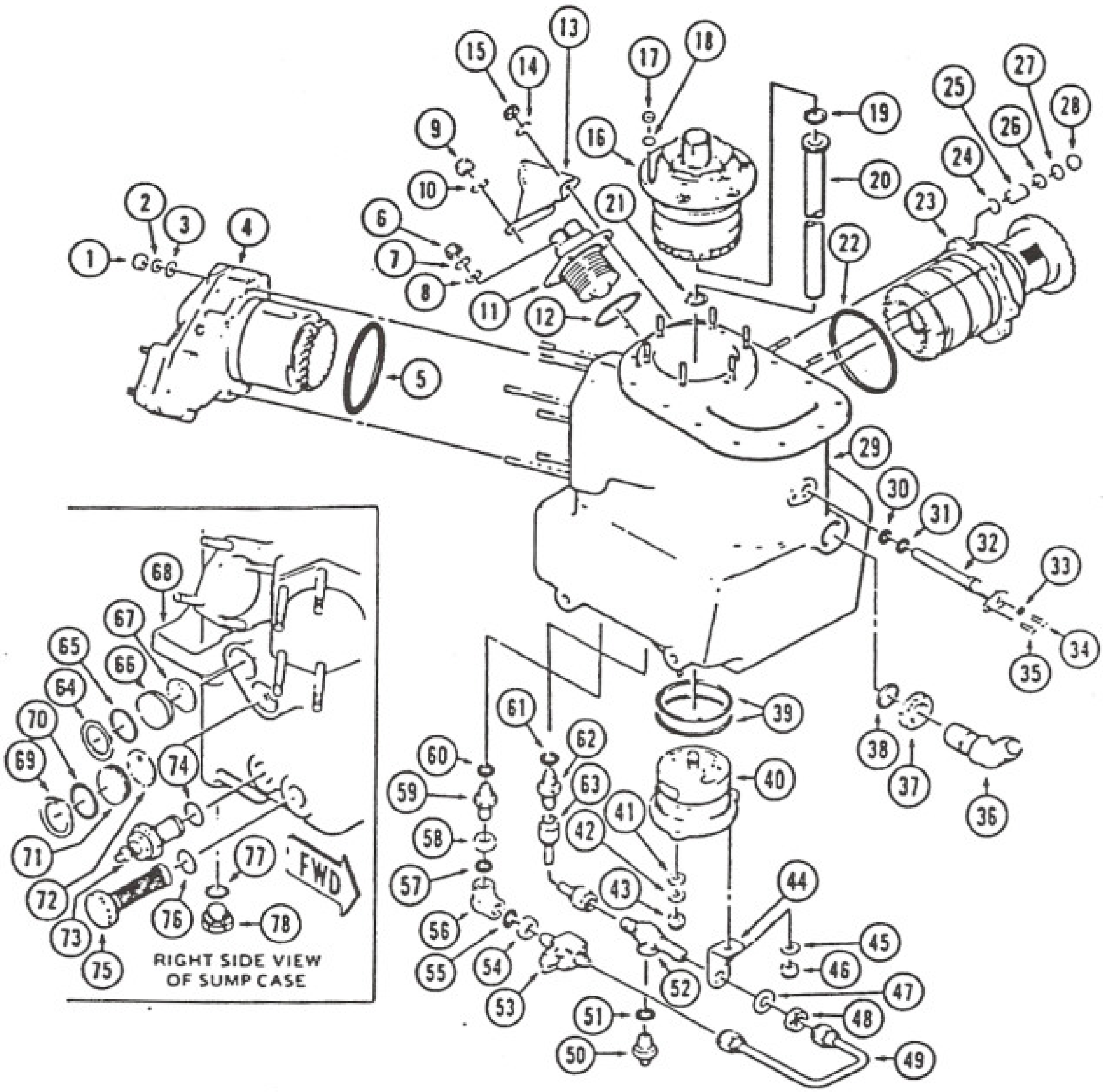
1. Bolt
2. Top case
3. Packing
4. Collector
5. Retainer ring
6. Upper planetary
7. Mast driving adapter
8. Extension
9. Upper bearing
10. Outer liner
11. Upper sun gear
12. Retainer ring
13. Oil deflector
14. Lower planetary
15. Outer liner
16. Lower bearing
17. Inner liner
18. Lower sun gear
19. Oil tube
20. Jet housing
21. Gasket
22. Ring gear
23. Jet housing

TRANSMISSION (SHEET 2 OF 2)



24. Input driven gear quill
25. Packing
26. Main case
27. Packing
28. Retainer ring
29. Bearing
30. Chip detector
31. Support case
32. Plug
33. Packing
34. Mast bearing
35. Mast guide ring
36. Retaining ring
37. Offset accessory drive quill
38. Retainer ring
39. Gear shaft bearing
40. Lift link fitting
41. Splined adapter shaft
42. Gasket
43. Accessory drive and sump assembly

ACCESSORY DRIVE AND SUMP ASSEMBLY (SHEET 1 OF 2)



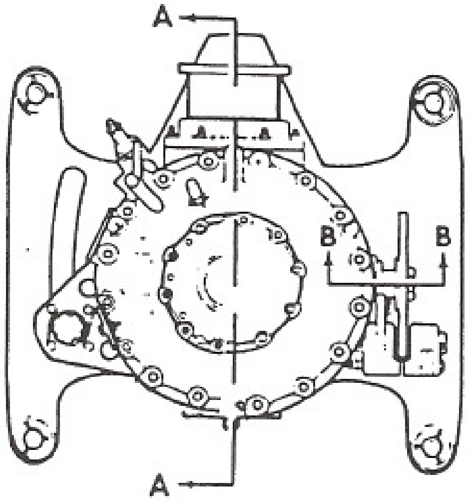
SUMP AND ACCESSORY DRIVE ASSEMBLY

Mounted to the lower side of the support case, this assembly serves as a sump for the transmission oil system and houses an input drive quill, the tail rotor drive quill, the hydraulic pump and tachometer drive quill, and the oil pump.

ACCESSORY DRIVE AND SUMP ASSEMBLY (SHEET 2 OF 2)

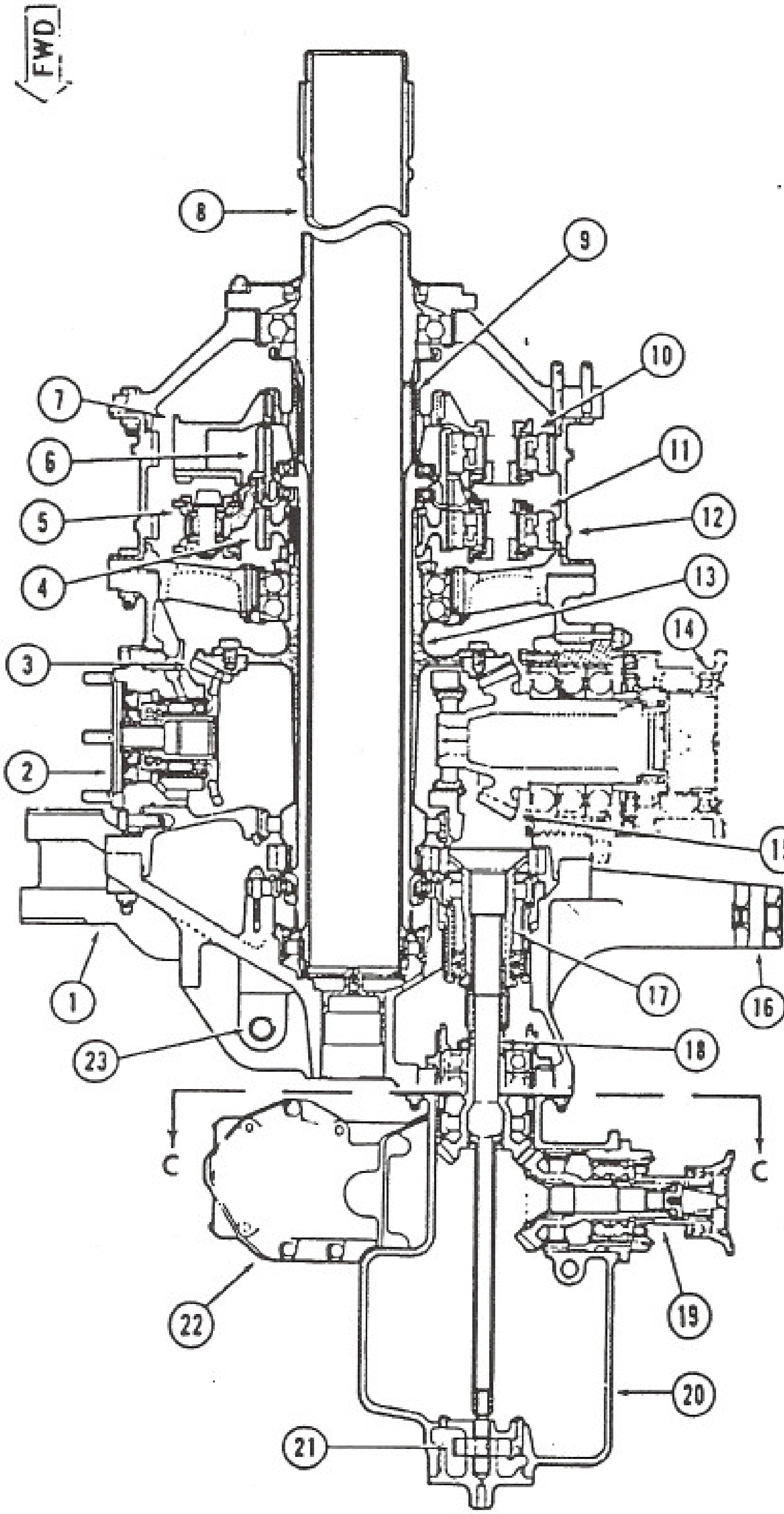
1. Nut
2. Washer, steel
3. Washer, aluminum
4. Hydraulic pump and tachometer drive quill
5. Packing
6. Nut
7. Washer, steel
8. Washer, aluminum
9. Nut
10. Washer
11. Oil filter
12. Packing
13. Bracket
14. Washer
15. Nut
16. Sump input quill
17. Nut
18. Washer
19. Retainer
20. Pump dri haft
21. Retainer ring
22. Packing
23. Tail rotor drive quill
24. Washer, aluminum
25. Spacer
26. Washer, steel
27. Washer, steel
28. Nut
29. Sump case
30. Packing
31. Packing
32. Jet No. 4
33. Washer, sealing
34. Screw
35. Screw
36. Elbow
37. Nut
38. Packing
39. Packing (Two)
40. Oil pump
41. Washer, aluminum
42. Washer, steel
43. Nut
44. Bracket
45. Washer, steel
46. Nut
47. Washer, aluminum
48. Nut
49. Tube assembly
50. Union
51. Packing
52. Tee
53. Drain valve
54. Nut
55. Packing
56. Elbow
57. Packing
58. Nut
59. Union
60. Packing
61. Packing
62. Union
63. Tube assembly
64. Retainer
65. Packing
66. Glass
67. Oil level indicator
68. Filter scupper
69. Retainer
70. Packing
71. Glass
72. Oil level indicator
73. Chip detector
74. Packing
75. Pump screen
76. Packing
77. Packing
78. Plug, threaded

Bell



VIEW LOOKING DOWN

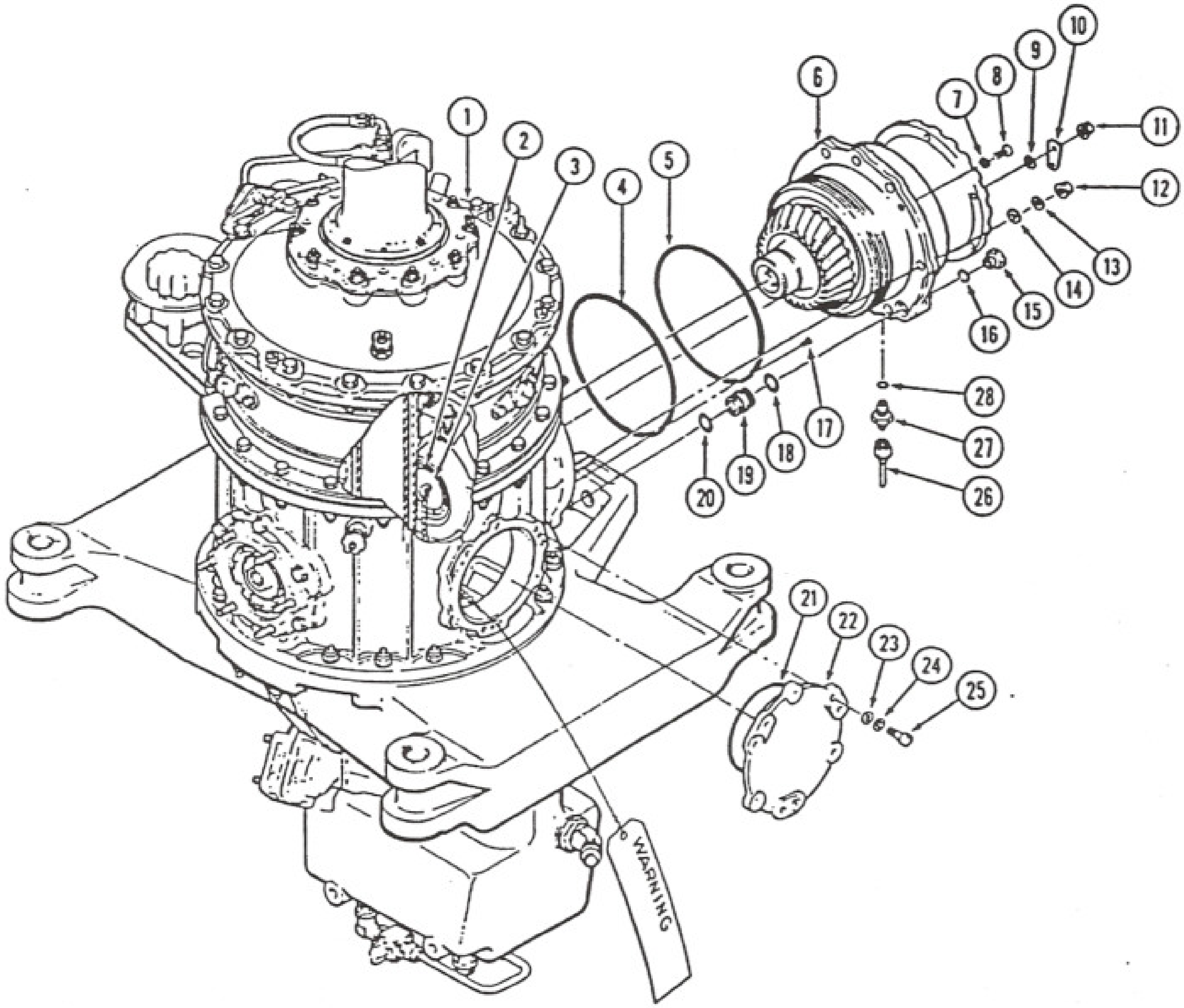
1. Support Case
2. Quill Assy, Hydraulic Pump
3. Bevel Gear, Input Driven Quill
4. Lower Sun Gear
5. Lower Planetary Carrier
6. Upper Sun Gear
7. Upper Planetary Carrier
8. Rotor Mast
9. Mast Adapter
10. Planetary Assy, Upper
11. Planetary Assy, Lower
12. Ring Gear Assy
13. Quill Assy, Input Driven
14. Quill Assy, Input
15. Bevel Pinion, Input Quill
16. Fifth Mount Attach Point
17. Quill Assy, Offset Accessory and Tail Rotor Drive
18. Quill Assy, Accessory and Tail Rotor Drive
19. Quill Assy, Tail Rotor
20. Drive and Sump Assy
21. Oil Pump
22. Quill Assy, Hydraulic Pump and Tach Generator
23. Lift Link Attach Point



SECTION A-A

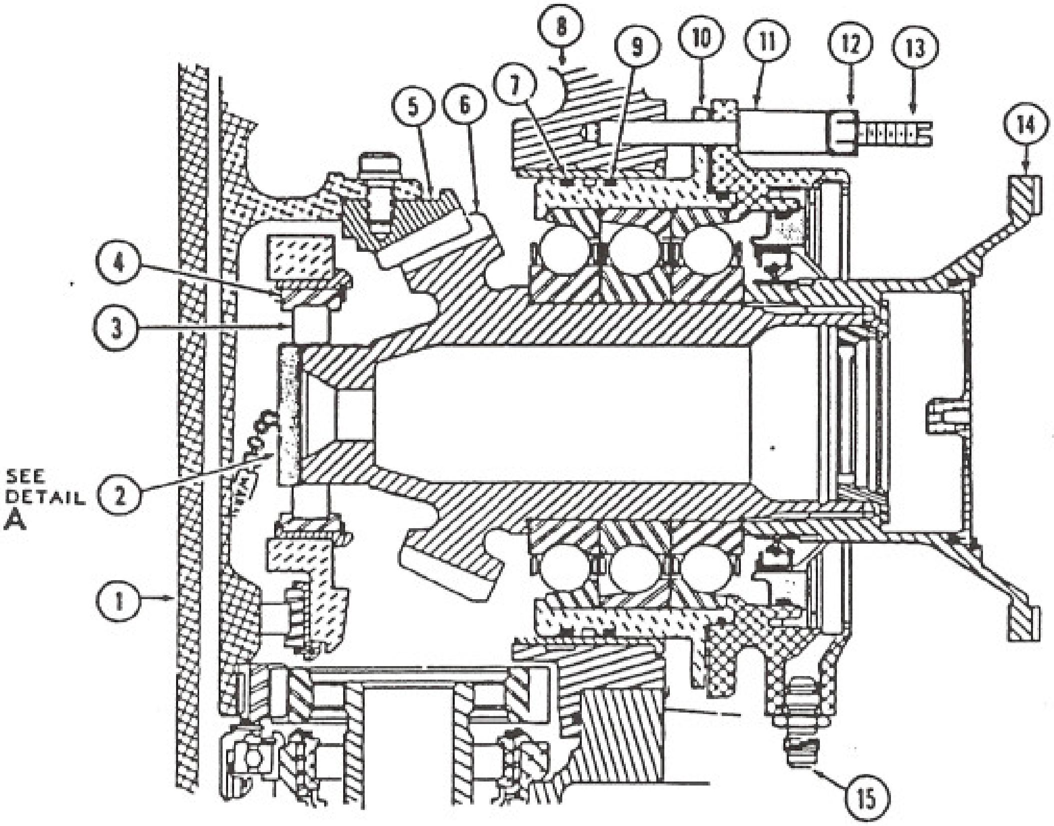
Transmission Cross-Section

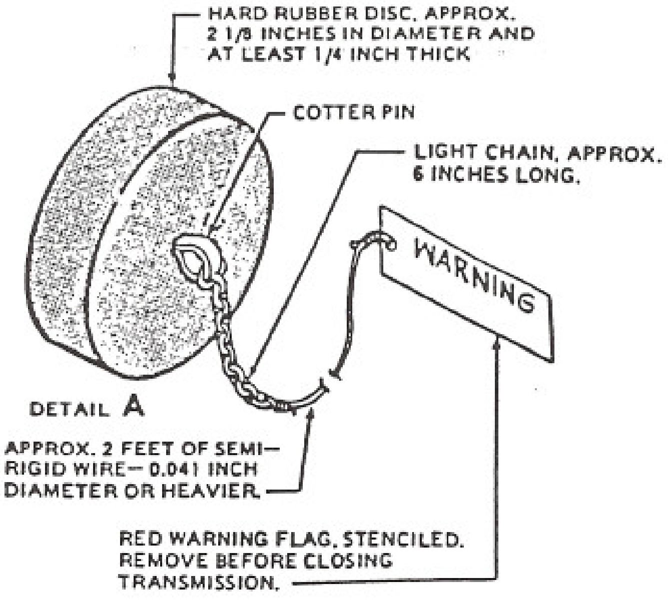
INPUT DRIVE QUILL REMOVAL



1. Transmission
2. Bearing
3. Work aid (rubber plug)
4. Packing
5. Packing
6. Main input quill
7. Aluminum washer
8. Screw
9. Aluminum washer
10. Clip
11. Nut
12. Nut
13. Thin steel washer
14. Aluminum washer
15. Plug
16. Packing
17. Set screw
18. Packing
19. Oil transfer tube
20. Packing
21. Packing
22. Cover
23. Aluminum washer
24. Steel washer
25. Bolt
26. Tube (seal drain)
27. Union
28. Packing

INPUT DRIVE QUILL INSTALLATION





DETAIL A

1. Main rotor mast
2. Work aid plug
3. Bearing (roller)
4. Bearing outer race
5. Input gear quill (driven gear)
6. Input quill pinion
7. Packing
8. Transmission main bevel gear case
9. Packing
10. Main input quill sleeve
11. Spacer
12. Nut
13. Pusher set stud (T101586-5)
14. Curvic coupling adapter
15. Drain tube union

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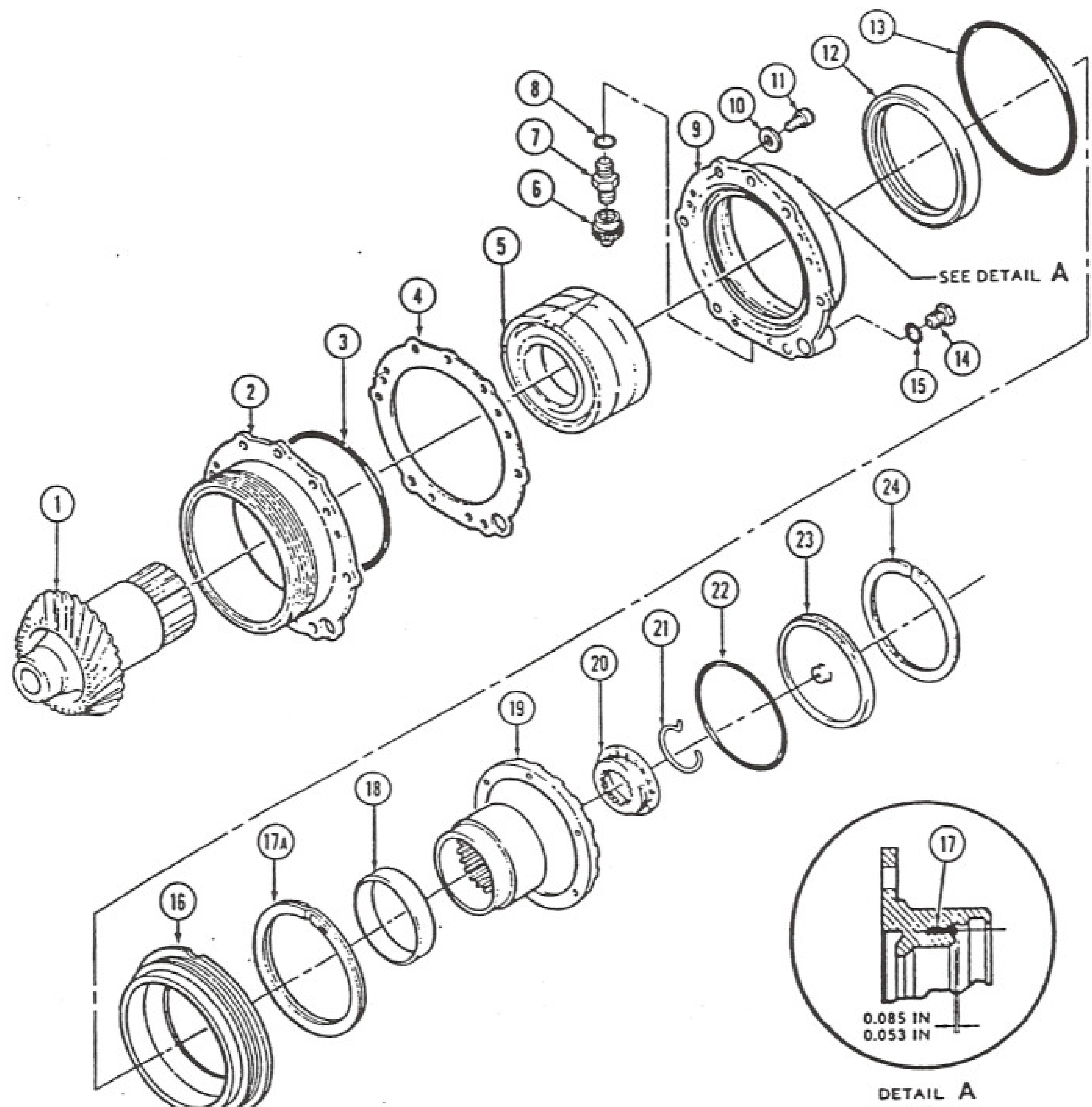
MAIN INPUT QUILL



1. Pinion
2. Sleeve
3. Packing
4. Shim
5. Triplex bearing
6. Cap
7. Union
8. Packing
9. Cap
10. Washer
11. Screw
12. Seal
13. Packing
14. Plug
15. Packing
16. Sleeve
17. Pin

17A. Retainer ring

18. Wear sleeve
19. Adapter
20. Nut
21. Lockspring
22. Packing
23. Plate
24. Retainer ring

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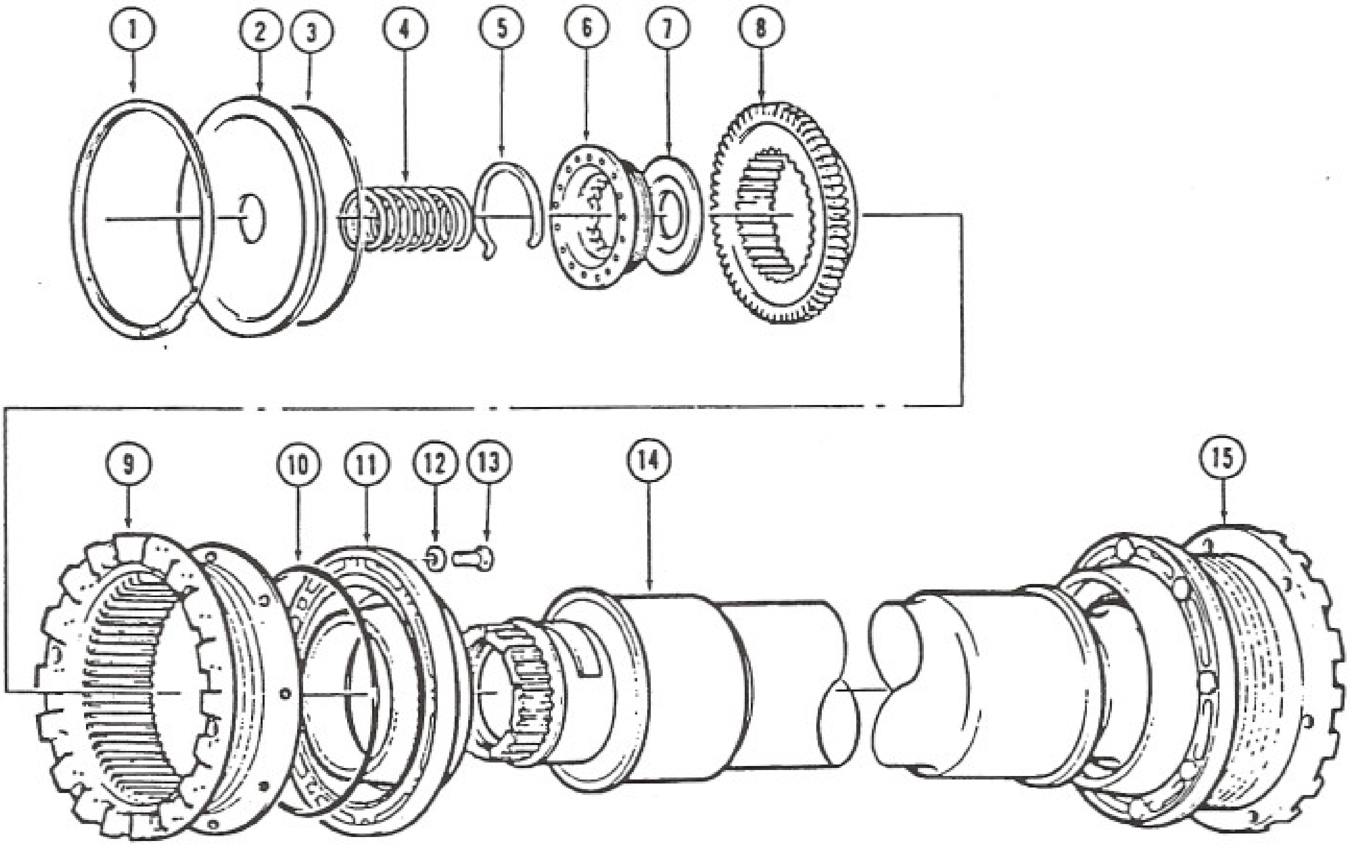


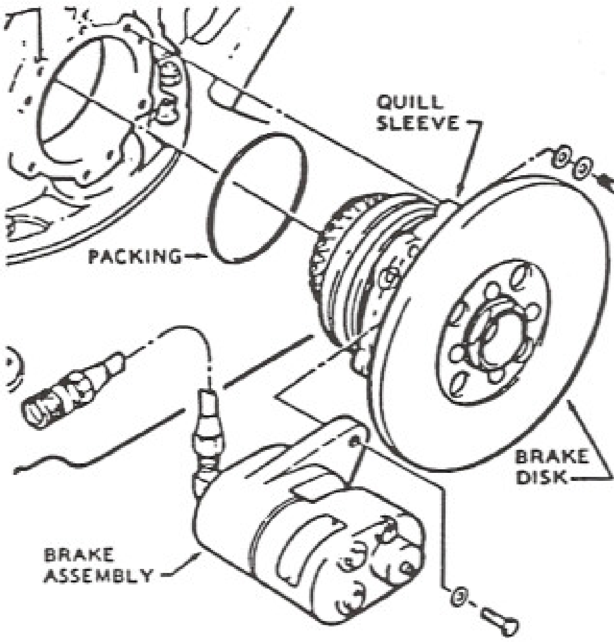
1. Retaining Ring
2. Retainer
3. Packing
4. Spring
5. Lock Spring
6. Nut
7. Spring Retainer
8. Inner Coupling
9. Outer Coupling
10. Packing
11. Boot
12. Washer
13. Bolt
14. Shaft
15. Coupling Assembly

Main Drive Shaft Assembly

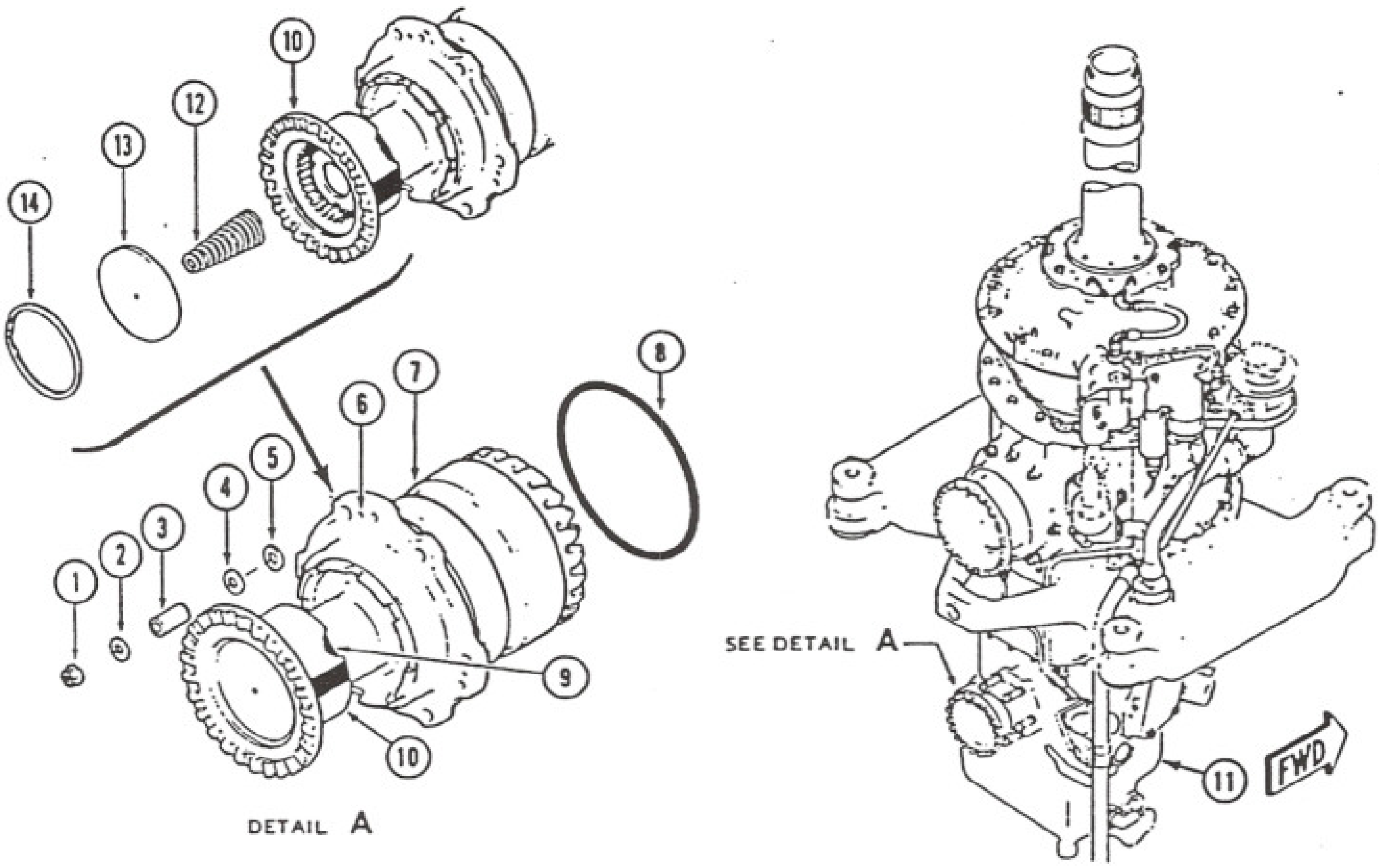
MAIN DRIVE SHAFT ASSEMBLY

The main drive shaft is installed between an adapter on the engine combining gear box and the input drive quill on the transmission. Flexibility of the couplings is provided by a floating-splined method of attachment on the shaft, to accommodate movement of the transmission on pylon mounts. A spring in each coupling assists in centering of the shaft during operation and tends to extend couplings when shaft is removed for maintenance. Shaft couplings are attached to the engine adapter and the transmission input drive quill by bolts.

ROTOR BRAKE QUILL

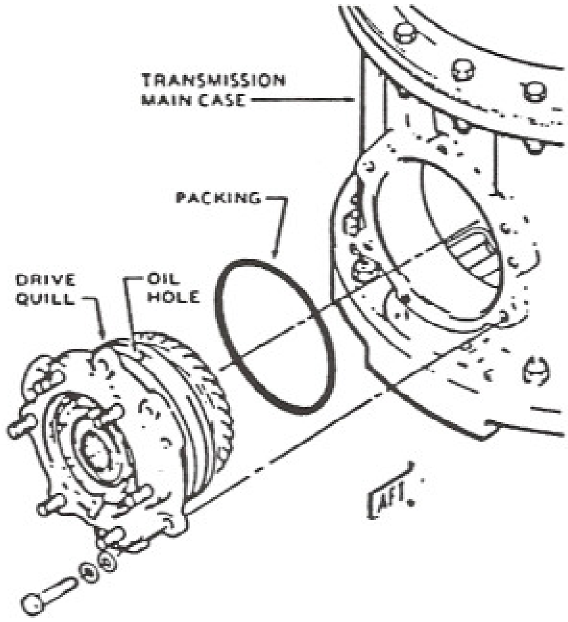


TAIL ROTOR DRIVE QUILL

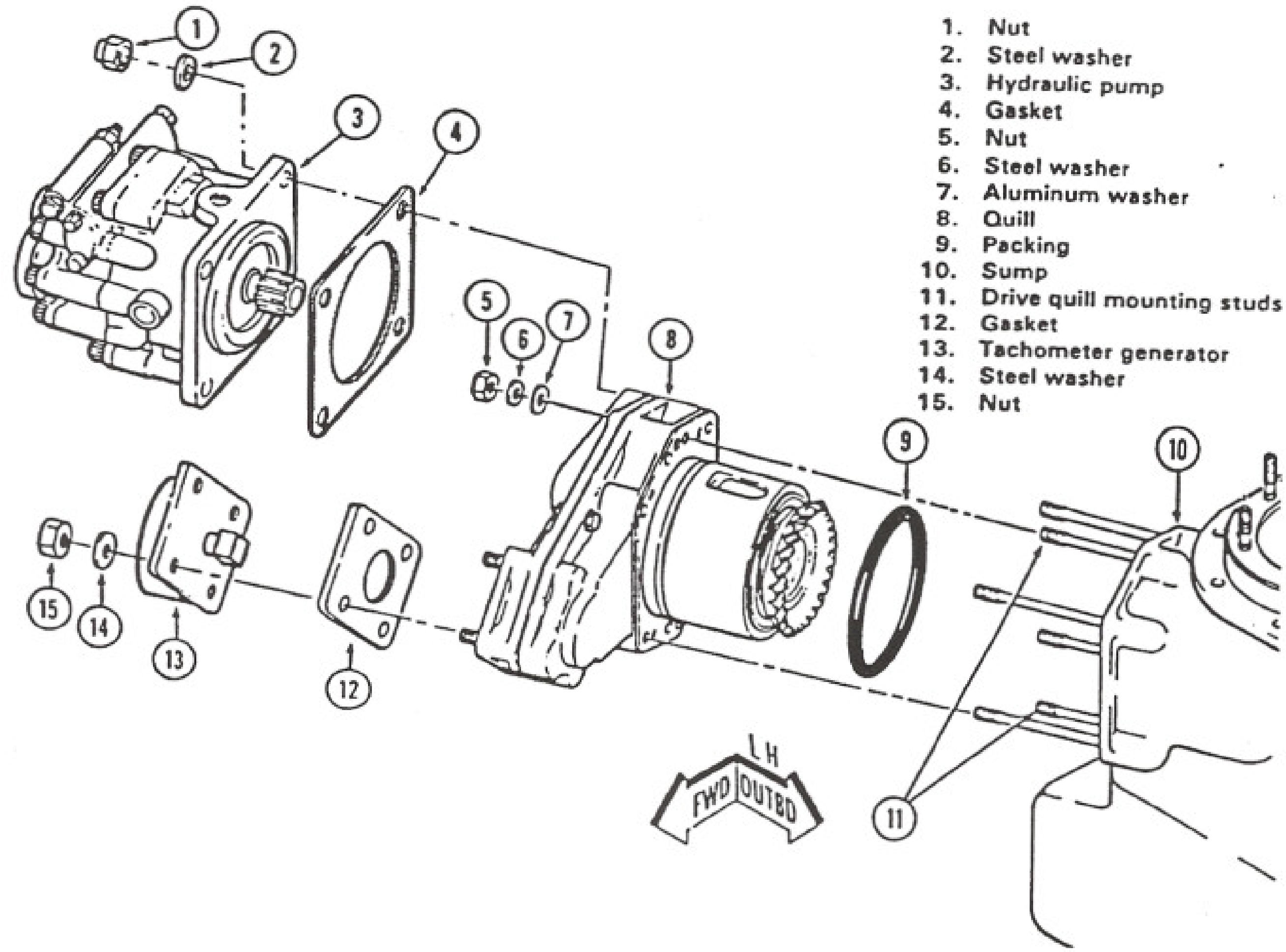


1. Nut
2. Steel washer
3. Spacer
4. Steel washer
5. Washer
6. Jackscrew hole
7. Tail rotor drive quill
8. Packing
9. Seal
10. Coupling
11. Sump assembly
12. Spring
13. Seal plate
14. Retainer ring

NO. 2 HYDRAULIC PUMP DRIVE QUILL



HYDRAULIC PUMP AND TACHOMETER DRIVE QUILL

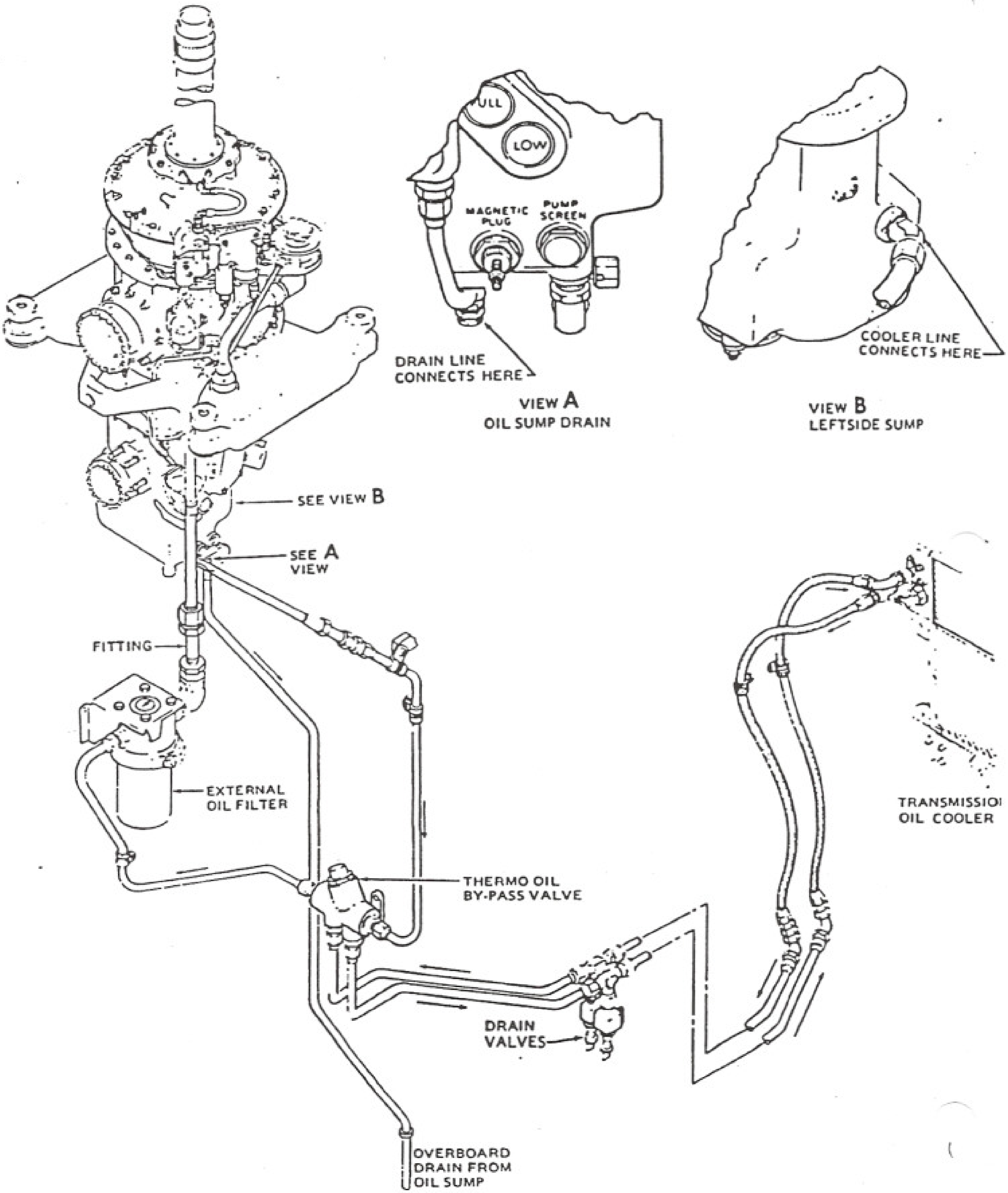


1. Nut
2. Steel washer
3. Hydraulic pump
4. Gasket
5. Nut
6. Steel washer
7. Aluminum washer
8. Quill
9. Packing
10. Sump
11. Drive quill mounting studs
12. Gasket
13. Tachometer generator
14. Steel washer
15. Nut

412040-12A

Bell

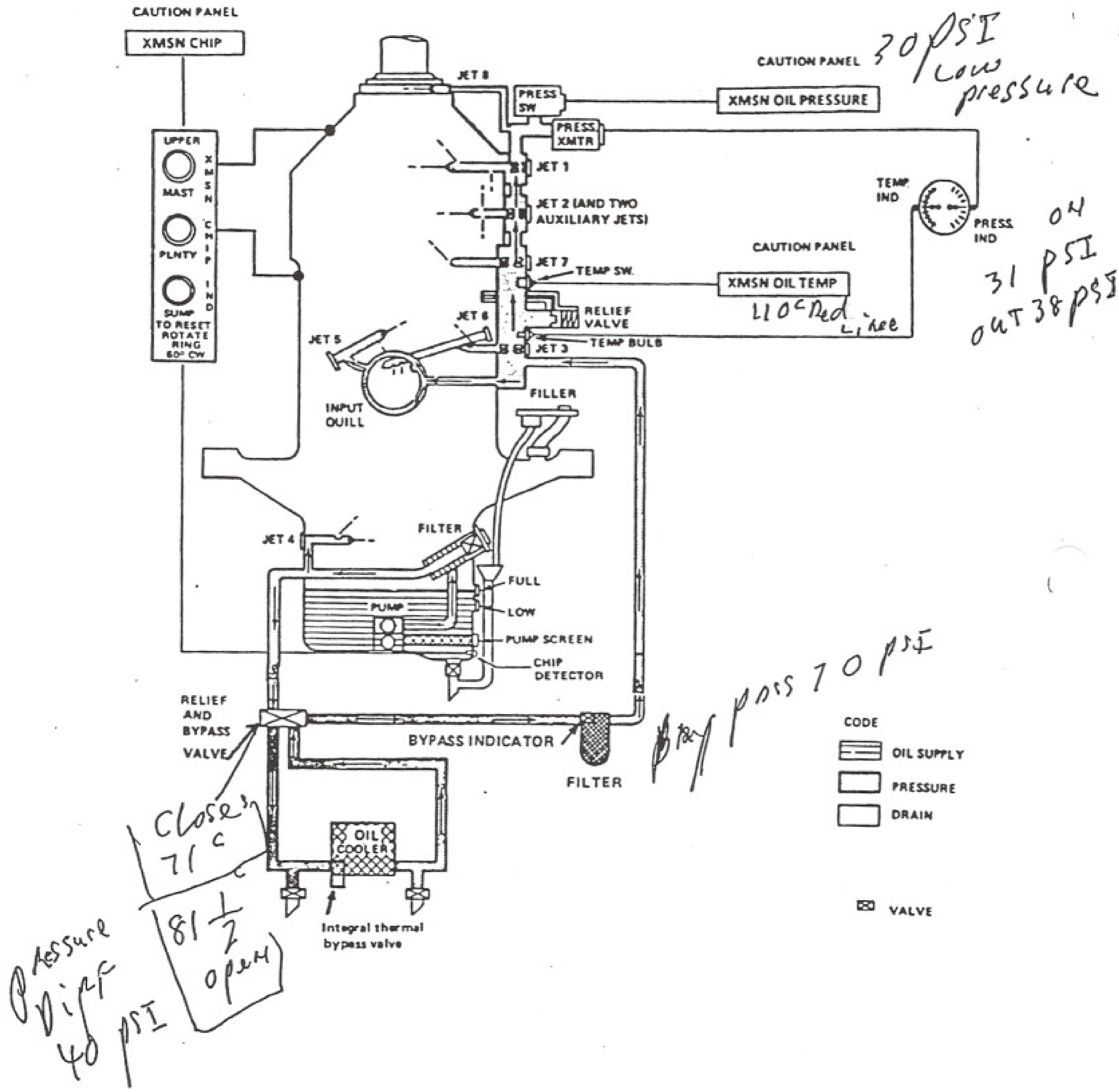
TRANSMISSION OIL SYSTEM



TRANSMISSION OIL SYSTEM

The transmission is lubricated by an oil system which is independent of the engine oil systems, except that oil coolers are mounted together and use the same blowers. Oil supply from the transmission sump is circulated under pressure by a transmission driven gerotor type pump through internal passages, through a filter to a sump outlet and external lines to a thermo by-pass valve. Under normal conditions the oil is routed to an oil cooler that contains a thermal bypass valve. Oil flows from the oil cooler to an externally mounted filter, then to a manifold on the transmission main case. This manifold is equipped with a relief valve to regulate system pressure and distributes oil through jets and internal passages to lubricate bearings and gears inside the transmission, where oil drains back to the sump. Oil temperature and pressure gage indications are provided by a thermobulb and a pressure transmitter. A thermoswitch and a pressure switch will light caution panel segments lettered XMSN OIL TEMP and XMSN OIL PRESSURE (low pressure) if such conditions occur. Oil system servicing provisions are mainly accessible from right side of transmission. Filler neck is at top right, under pylon fairing. Oil level sight gages on sump case can be checked through a view port on pylon island in cabin. Sump oil filter, pump screen, and magnetic plug can be reached through access door at same location. A drain valve is located under transmission sump. Two cooler line drain valves are in bottom of fuselage compartment just behind aft cross tube of landing gear.

TRANSMISSION OIL SYSTEM SCHEMATIC

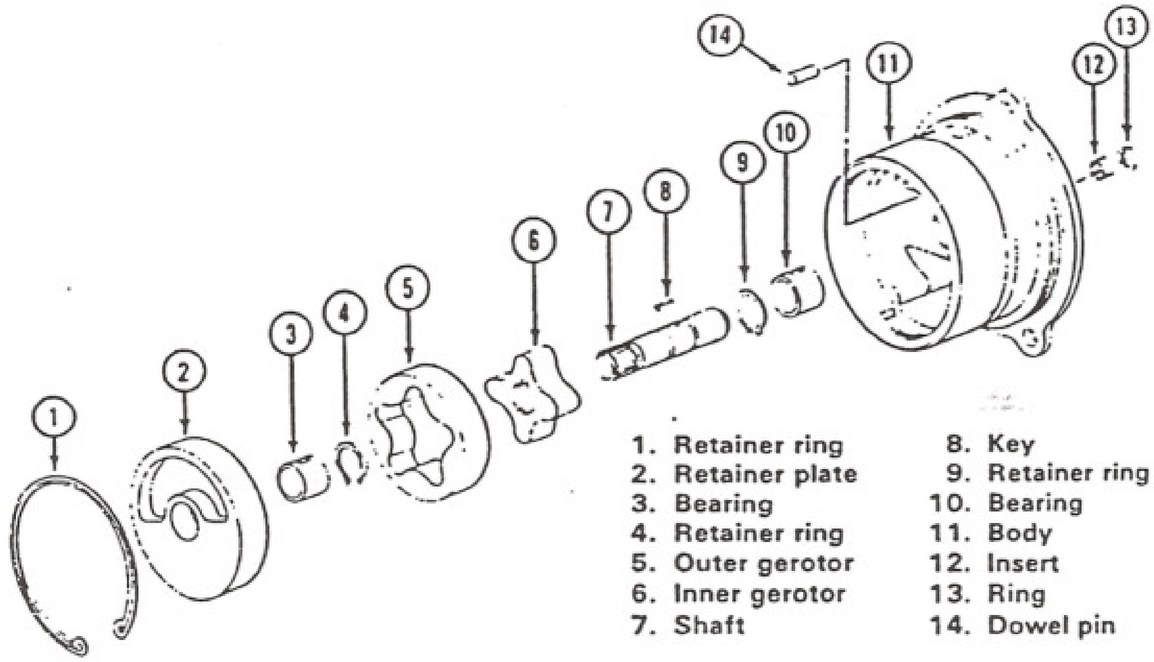


TRANSMISSION OIL JETS

Oil jet assemblies are installed from the exterior of the transmission at various points, passing through the walls of internal passages which deliver oil under pressure, and extend inside the transmission case to deliver directed oil on gears and bearings. Each jet is identified with its mounting port by matching stamped numerals. Attaching screw hole indexes the jet nozzle spray direction.

JET	LOCATION AND FUNCTION
No. 1	Right aft on top case. Sprays mast driving splines and upper stage planetary pinion bearings.
No. 2	On housing at right aft on ring gear case, with two auxiliary jets fed by external tubes and located 120 degrees apart on ring gear case. Sprays sun gear and pinion bearings of both planetary stages.
No. 3	On bottom of oil manifold at right aft on main case. Sprays input pinion and input driven gear leaving mesh and delivers oil to No. 6 jet inside case.
No. 4	On left side of sump case. Lubricates accessory drive gears and tail rotor drive quill.
No. 5	Left aft main case, beside input drive quill. Lubricates input pinion and input driven gear entering mesh.
No. 6	Right side of main case, near oil manifold. Receives oil from No. 3 jet inside case. Sprays inboard bearing of input pinion.
No. 7	Lubricates the support bearing of the vertical shaft in the input driven gear support case.
No. 8	Right rear side of upper mast bearing retainer plate. Provides lubrication for upper mast bearing assembly.

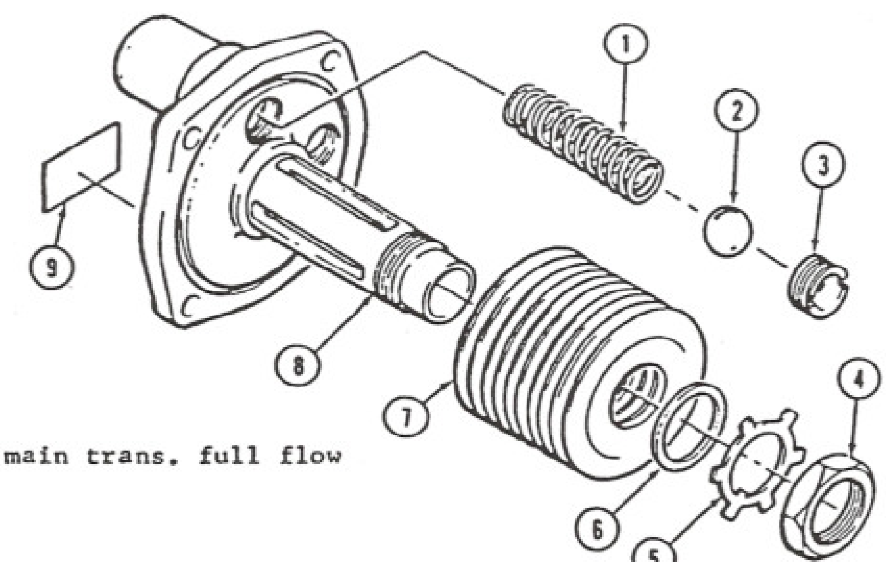
TRANSMISSION OIL PUMP ASSEMBLY



1. Retainer ring
2. Retainer plate
3. Bearing
4. Retainer ring
5. Outer gerotor
6. Inner gerotor
7. Shaft
8. Key
9. Retainer ring
10. Bearing
11. Body
12. Insert
13. Ring
14. Dowel pin

INTERNAL OIL FILTER

1. Spring
2. Ball
3. Set screw
4. Nut
5. Washer
6. Spacer
7. Wafer screens
8. Filter body
9. Name plate



See TB 412-91-94 for main trans. full flow debris monitor.

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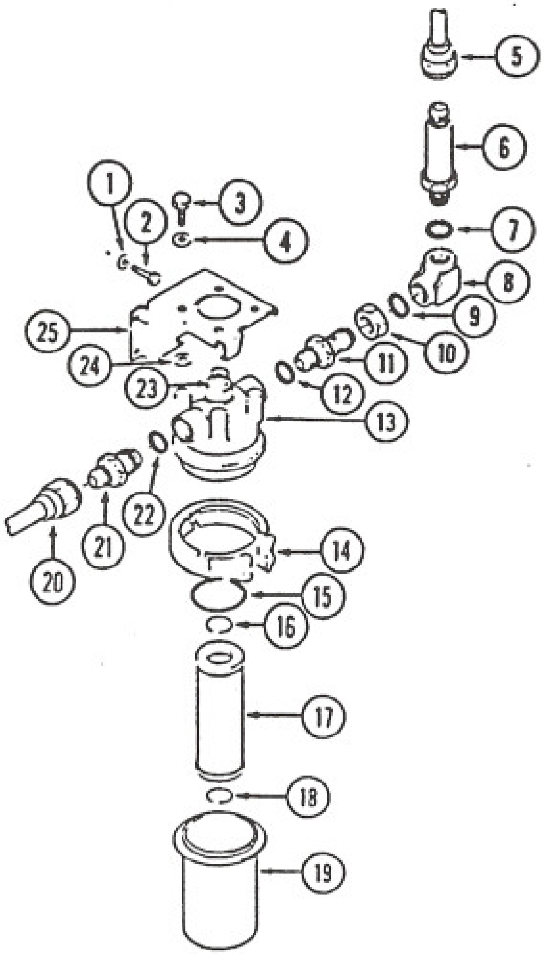
EXTERNAL OIL FILTER

1. Thin aluminum washers (4 places)
2. Bolt (4 places)
3. Bolt (4 places)
4. Thin aluminum washers (4 places)
5. Outlet hose
6. Fitting
7. Packing
8. Elbow
9. Packing
10. Checknut
11. Union
12. Packing
13. Filter head
14. V-band clamp
15. Packing
16. Packing
17. Filter element
18. Packing
19. External oil filter body
20. Inlet tube
21. Reducer
22. Packing
23. Bypass indicator
24. Spacer (4 places)
25. Filter bracket



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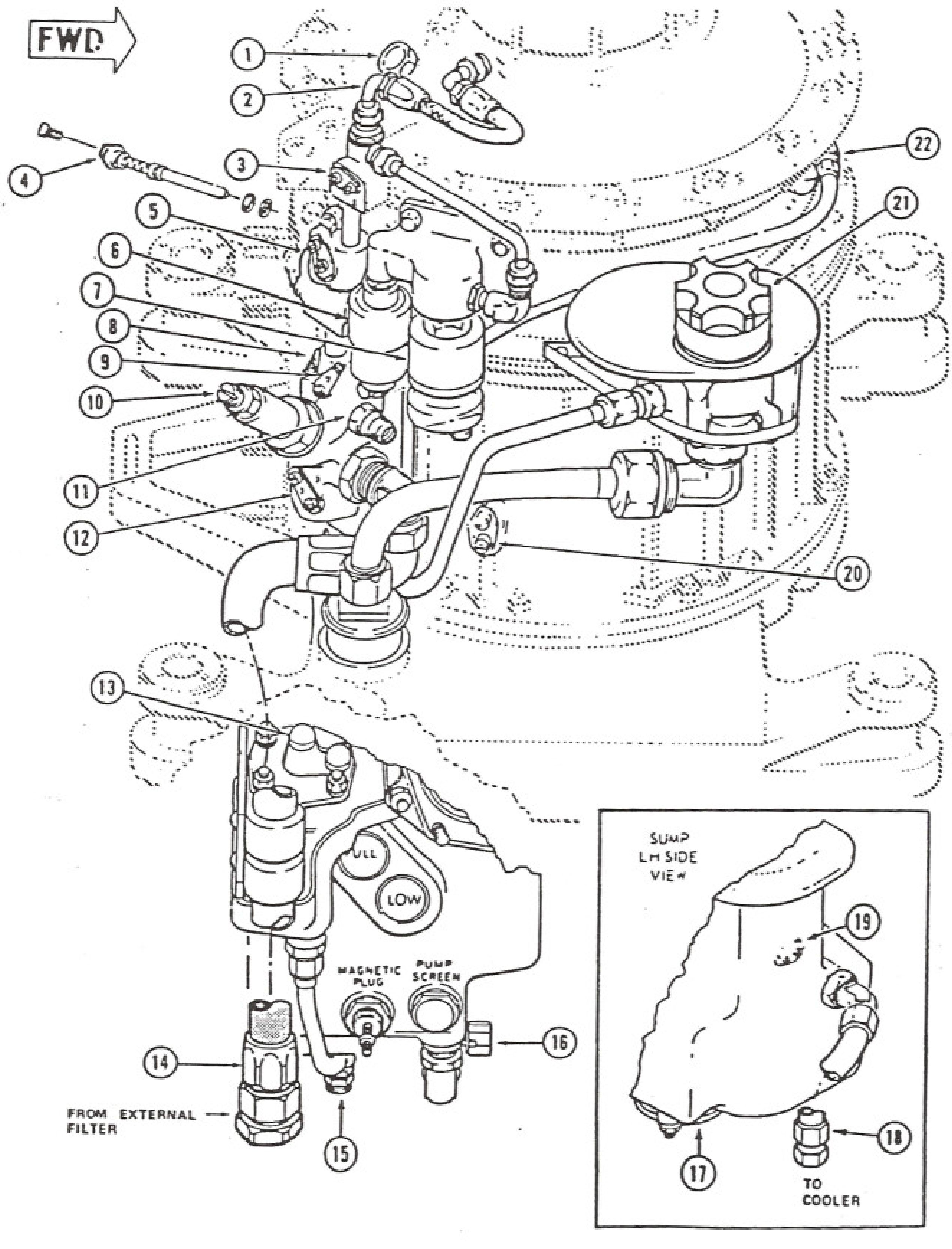
TRANSMISSION OIL SYSTEM COMPONENTS (SHEET 1 OF 2)

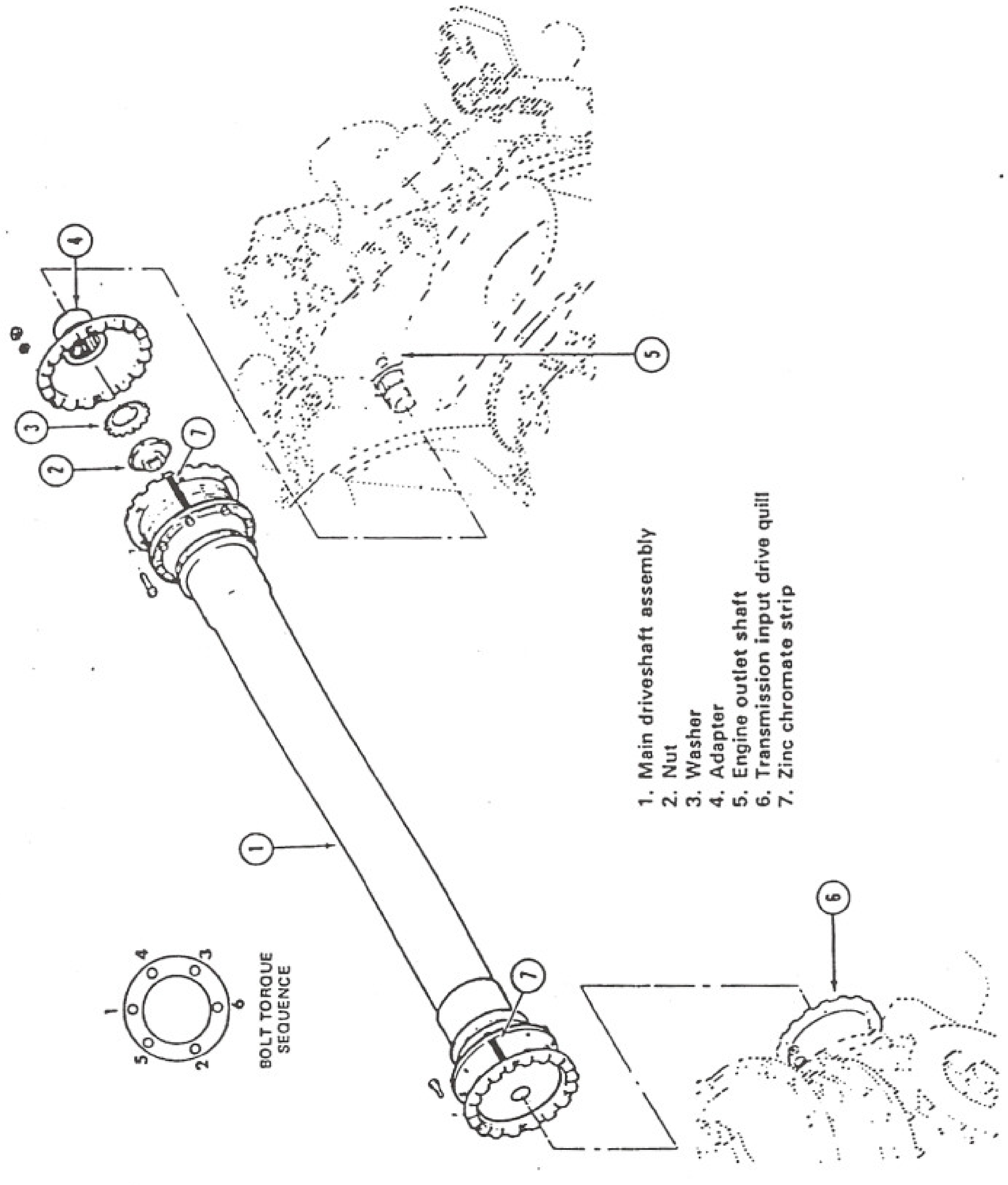


TRANSMISSION OIL SYSTEM COMPONENTS (SHEET 2 OF 2)

1. Plug
2. Line to mast jet
3. Jet No. 1
4. Jet No. 5
5. Jet No. 2
6. Pressure switch
7. Pressure transmitter
8. Thermoswitch
9. Jet No. 7
10. Pressure relief valve
11. Temperature bulb
12. Jet No. 3
13. Sump filter
14. Inlet hose
15. Drain hose connection
16. Drain valve
17. Pump
18. Outlet hose
19. Jet No. 4
20. Jet No. 6
21. Filler cap
22. Auxiliary jet

Bell

MAIN DRIVESHAFT INSTALLATION

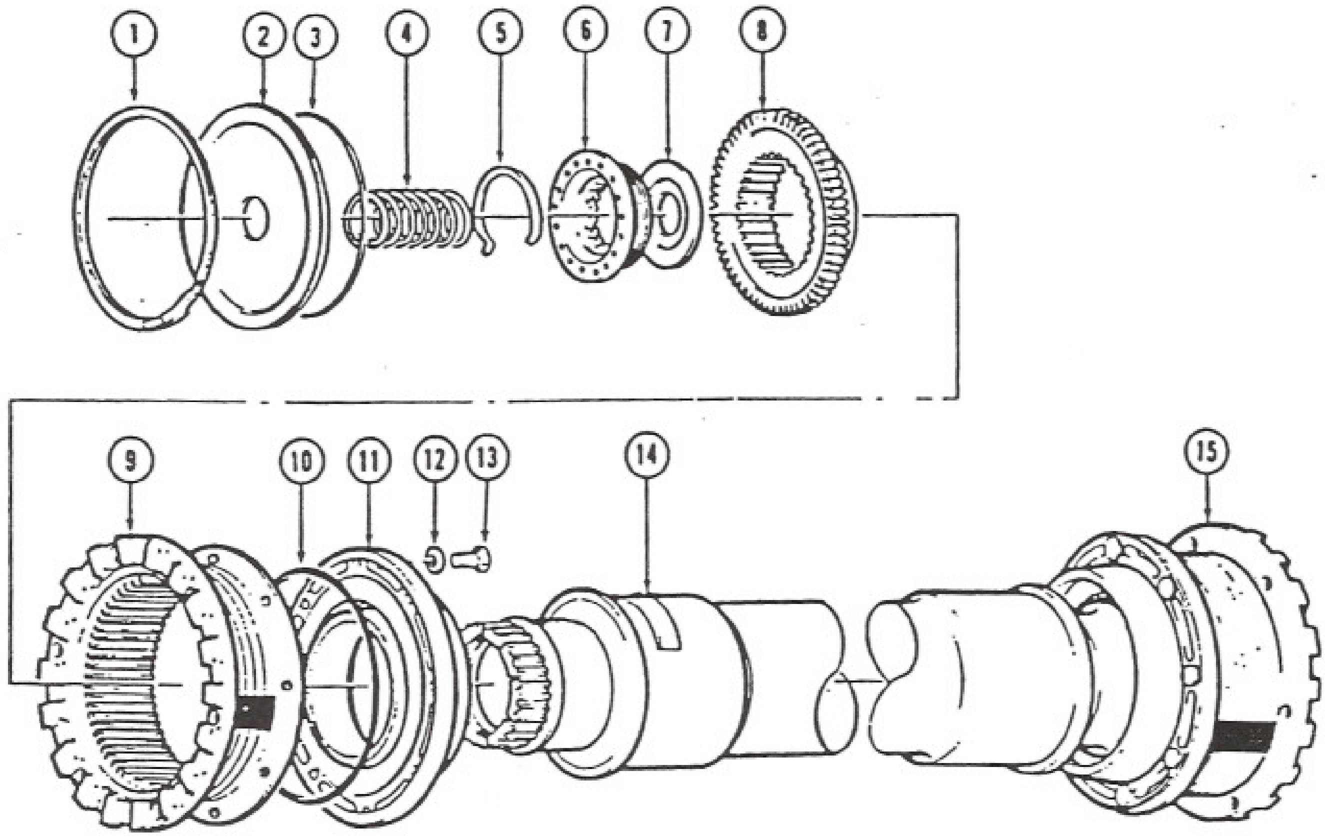


MAIN DRIVESHAFT

The main drive shaft is installed between an adapter on the engine reduction gear box and the input drive quill on the transmission. Flexibility of the couplings is provided by a floating-splined method of attachment on the shaft, to accommodate movement of the transmission on pylon mounts. A spring in each coupling assists in centering of the shaft during operation and tends to extend couplings when shaft is removed for maintenance. Shaft couplings are attached to the engine adapter and the transmission input drive quill by bolts.

Bell

MAIN DRIVESHAFT ASSEMBLY



1. Retaining ring
2. Retainer
3. Packing
4. Spring
5. Lock spring
6. Nut
7. Spring retainer
8. Inner coupling
9. Outer coupling
10. Packing
11. Boot
12. Washer
13. Bolt
14. Shaft
15. Coupling assembly

Bell

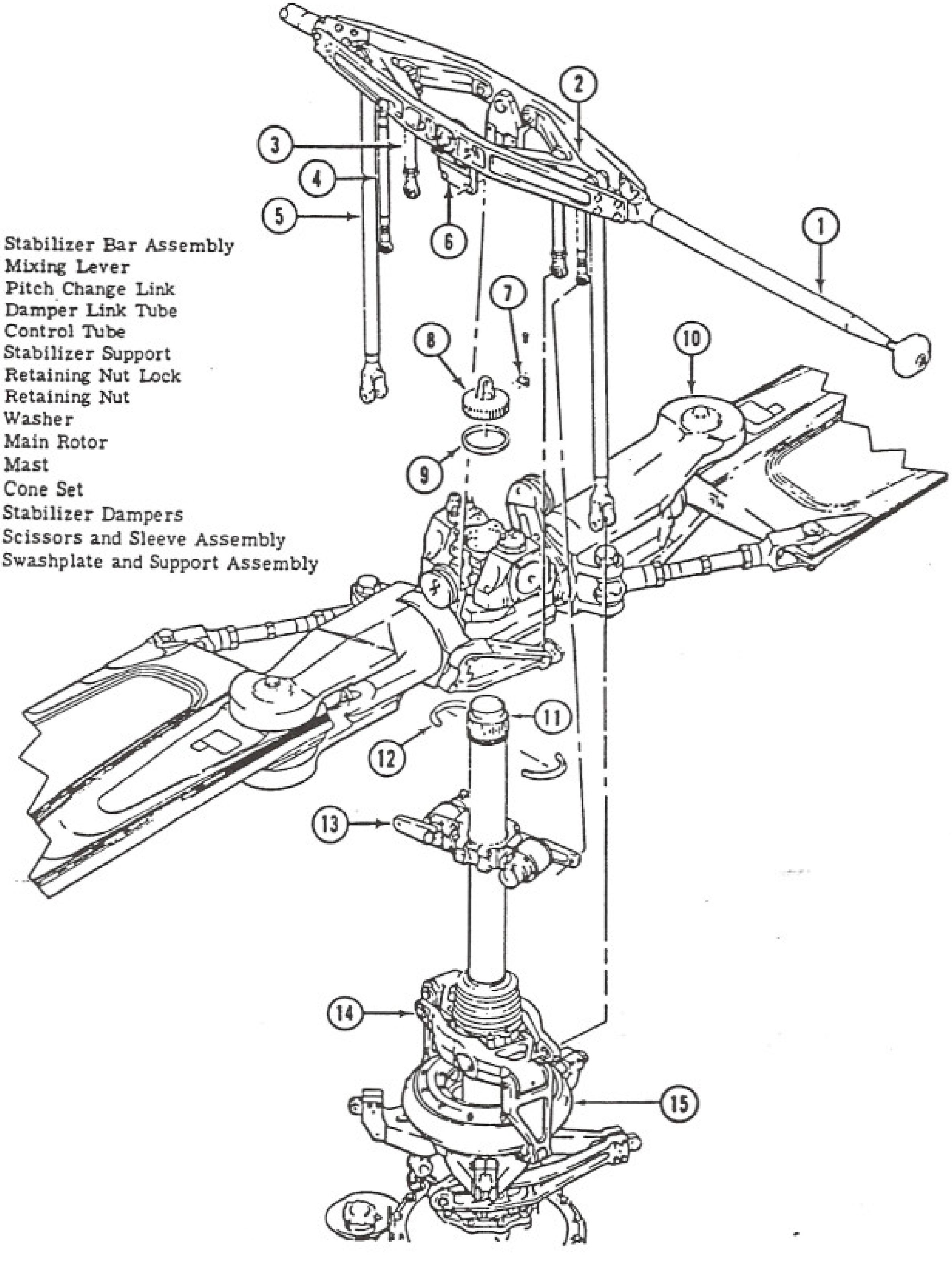
MAIN ROTOR GROUP

GENERAL

The main rotor group includes a two-blade semi-rigid type rotor, a stabilizer bar with dampers, a swashplate and support, a scissors and collective sleeve, and interconnecting linkage. Rotor hub yoke is underslung on its mounting trunnion through two pillow blocks which provide a flapping axis, and the all-metal blades are attached through grips which can turn on yoke spindles to change blade pitch. Hub trunnion is installed on splines at top of mast, supported by a cone set and secured by a retaining nut which also serves as mast cap and lifting eye. In operation, collective pitch control stick movements cause angular changes of both blade grips equally and simultaneously. Tilting of main rotor for directional control is accomplished by independent changes of each blade grip by means of cyclic controls. Stabilizer bar, mounted with its flapping axis crosswise to that of main rotor, is connected into rotor controls to provide greater stability for all flight conditions. Without restraint, bar would tend to stay in its original plane of rotation and hold the rotor to one plane. Since this would limit controllability too severely, this effect is modified by connecting bar to mast through hydraulic dampers. This induces bar to follow movements of mast, relative to rotor, with a slight time lag. Result is a compromise providing both stability and controllability.

MAIN ROTOR HUB AND BLADE ASSEMBLY

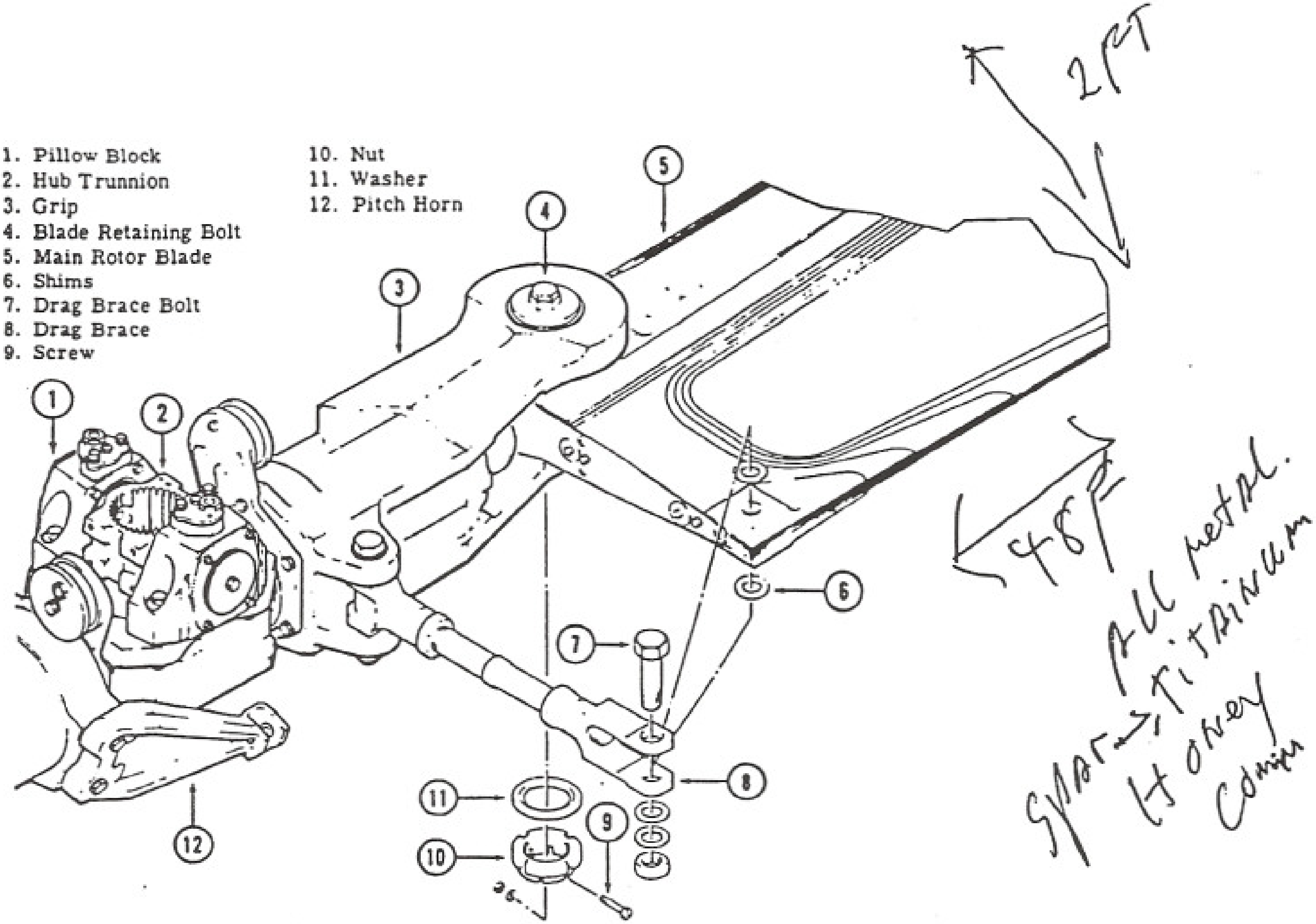
The main rotor blades are all-metal bonded assemblies, set into hub grips at a preconing angle and secured by a single retaining bolt in each grip. Each blade is formed of four major sections: main spar, honeycomb core, trailing edge extrusion, and nose block extrusions, all bonded to the skin by adhesive applied under heat and pressure. Reinforcing doublers, grip plates, and drag plates are attached on the blade butt end. Stainless steel strips cover leading edges for resistance to abrasion. A trim tab is provided on the trailing edge for tracking adjustments. A fitting on the blade tip, which is used in the flag-tracking procedure, has a hole for attachment of the rotor tie-down. An adjustable drag brace connects the trailing edge of the blade to the hub, providing a means of aligning blades. Blade grips and pillow blocks on the hub are lubricated with the same oil as that used for the engine, transmission, and gearboxes. Oil levels can be checked through the transparent covers. On the rotors, torsion on the retention strap within each blade grip performs the function of counteracting aerodynamic forces which tend to change blade pitch. Control linkage connects to a pitch horn on the leading side of each blade grip.



1. Stabilizer Bar Assembly
2. Mixing Lever
3. Pitch Change Link
4. Damper Link Tube
5. Control Tube
6. Stabilizer Support
7. Retaining Nut Lock
8. Retaining Nut
9. Washer
10. Main Rotor
11. Mast
12. Cone Set
13. Stabilizer Dampers
14. Scissors and Sleeve Assembly
15. Swashplate and Support Assembly

Main Rotor Installation

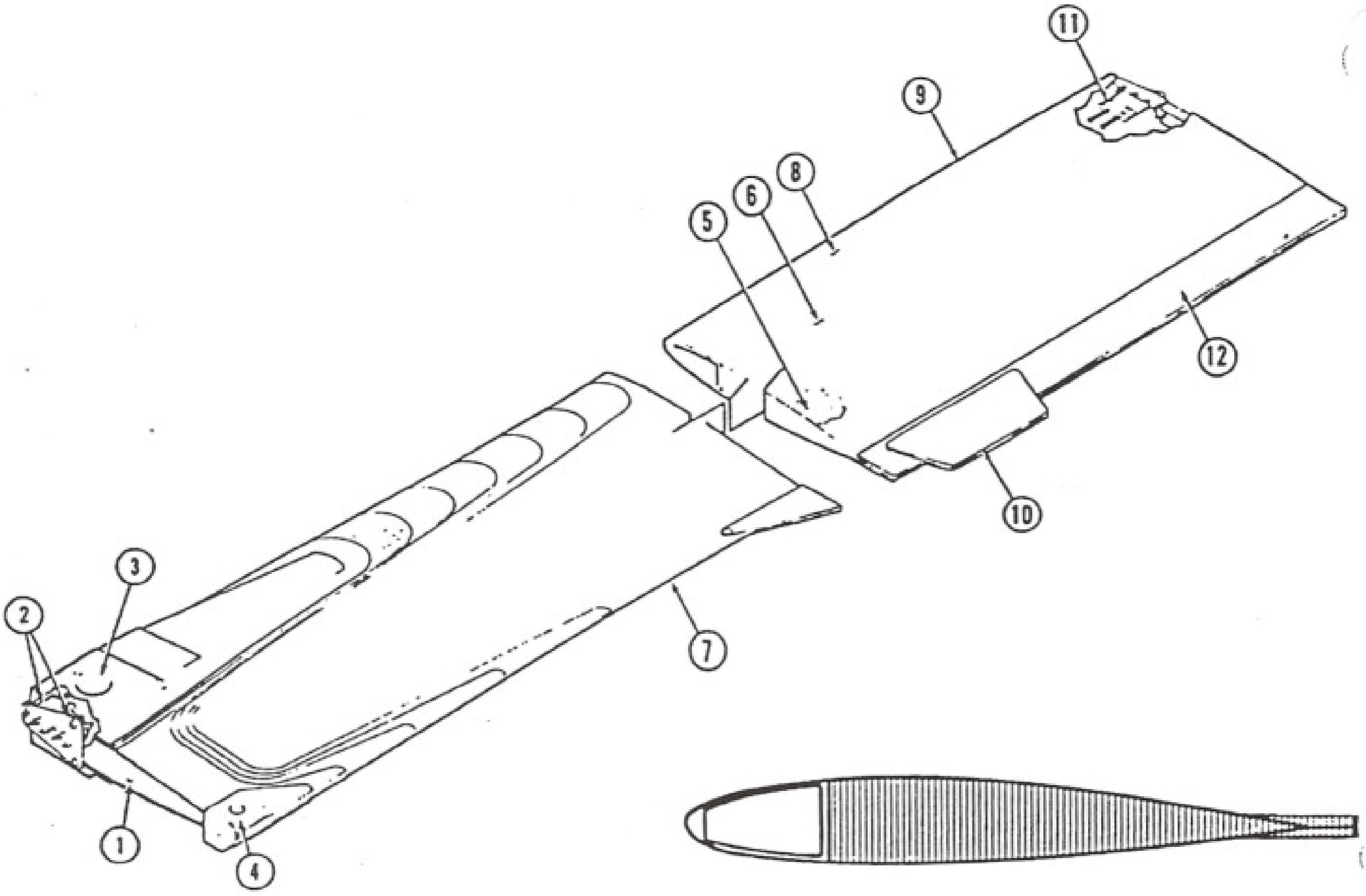
1. Pillow Block
2. Hub Trunnion
3. Grip
4. Blade Retaining Bolt
5. Main Rotor Blade
6. Shims
7. Drag Brace Bolt
8. Drag Brace
9. Screw
10. Nut
11. Washer
12. Pitch Horn



Main Rotor Hub and Blade Assembly

Rotor brake 30 35% Opp   40° manual

Notes



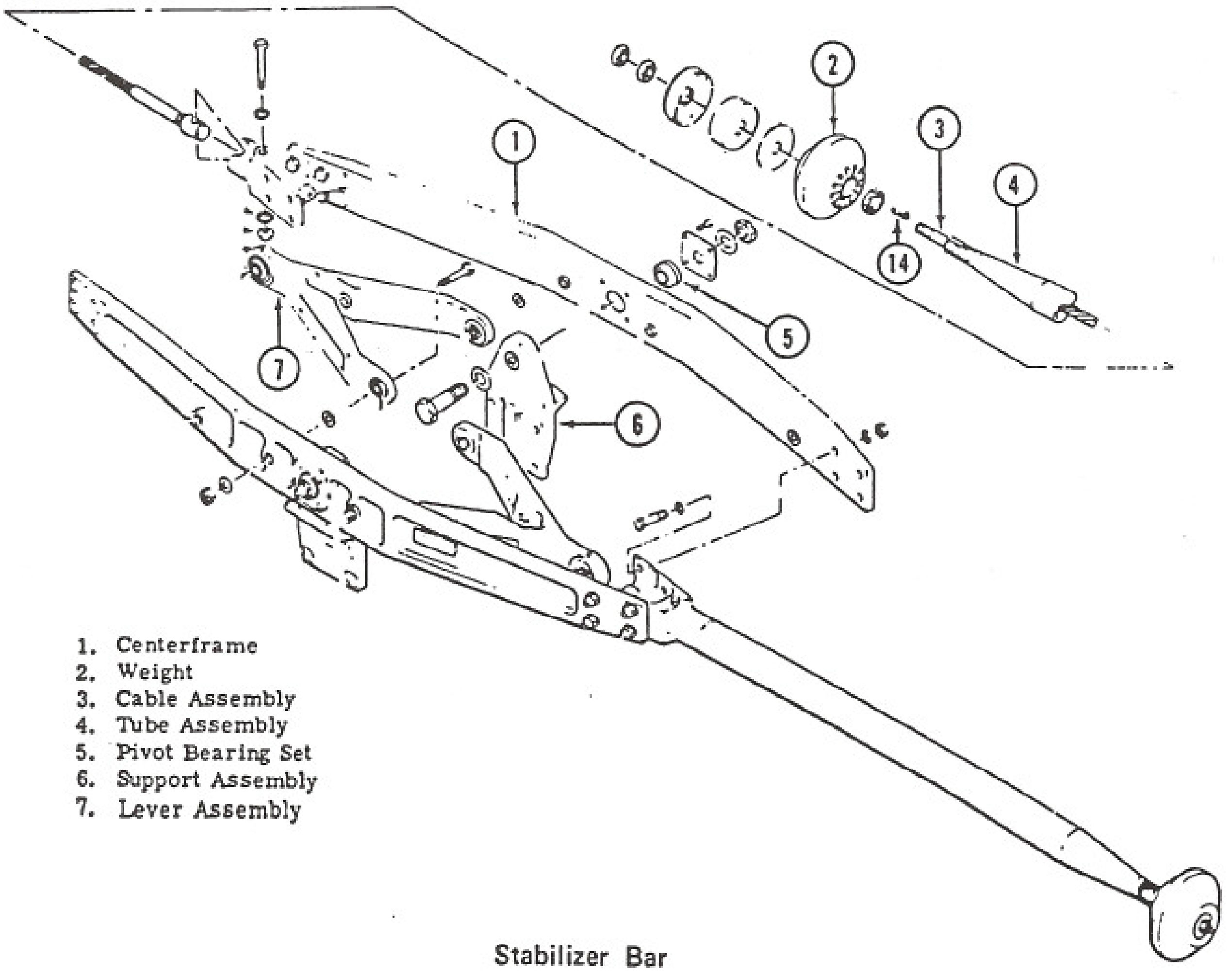
1. Butt Cover
2. Ballast Weights
3. Main Retention Bolt Hole
4. Drag Link Bolt Hole
5. Honeycomb Core
6. Skin
7. Trailing Edge Extrusion
8. Main Spar
9. Leading Edge
10. Trim Tab
11. Ballast Weights
12. Trailing Edge Extension

Blade Assembly

Notes

STABILIZER BAR

The stabilizer bar is attached to the mast at the main rotor hub trunnion. The bar is connected into the main rotor system in such a manner that the inherent inertia and gyroscopic action of the bar is introduced into the rotor system and provides a measure of stability for all flight conditions. If, while hovering, the helicopter attitude is disturbed, the bar, due to its gyroscopic action, tends to remain in its present plane. The relative movement between the bar and the mast causes the hub and blade assembly to feather and return the rotor to near its original plane of rotation. If the bar were completely unrestrained it would remain in its original plane of rotation and would induce stability to the point of removing all control from the pilot. Due to a restraining by dampening action, there is induced in the bar a mast following characteristic. This following time is regulated by the predetermined (built-in) dampening action of the two hydraulic dampers connected by linkage to the bar in such a manner that a movement of the mast is transmitted to the bar through the dampers at a rate determined by the design of the dampers. A compromise is met in which the bar provides the desired amount of stability and still allows the pilot complete responsive control of the helicopter.

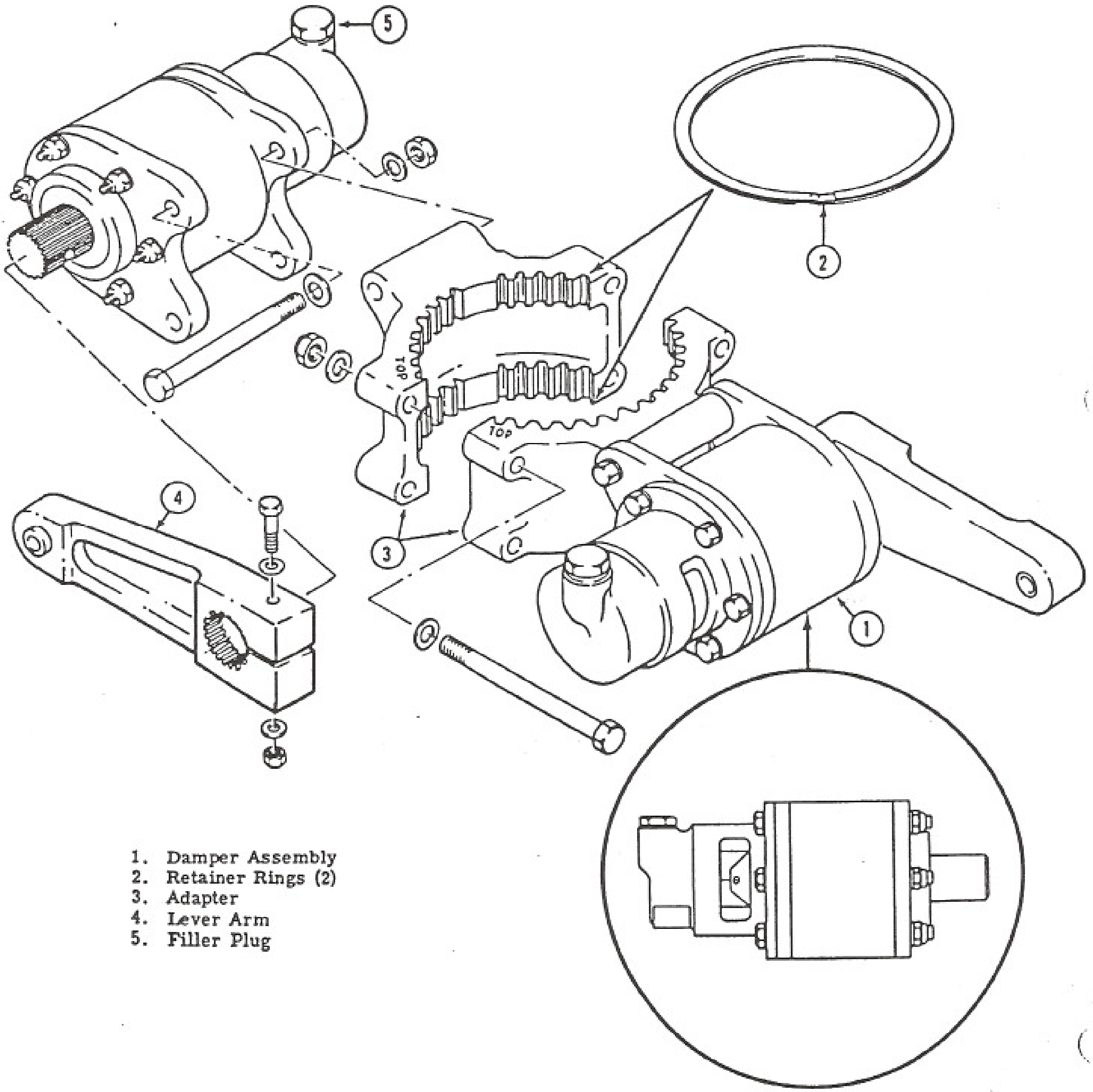


1. Centerframe
2. Weight
3. Cable Assembly
4. Tube Assembly
5. Pivot Bearing Set
6. Support Assembly
7. Lever Assembly

Stabilizer Bar

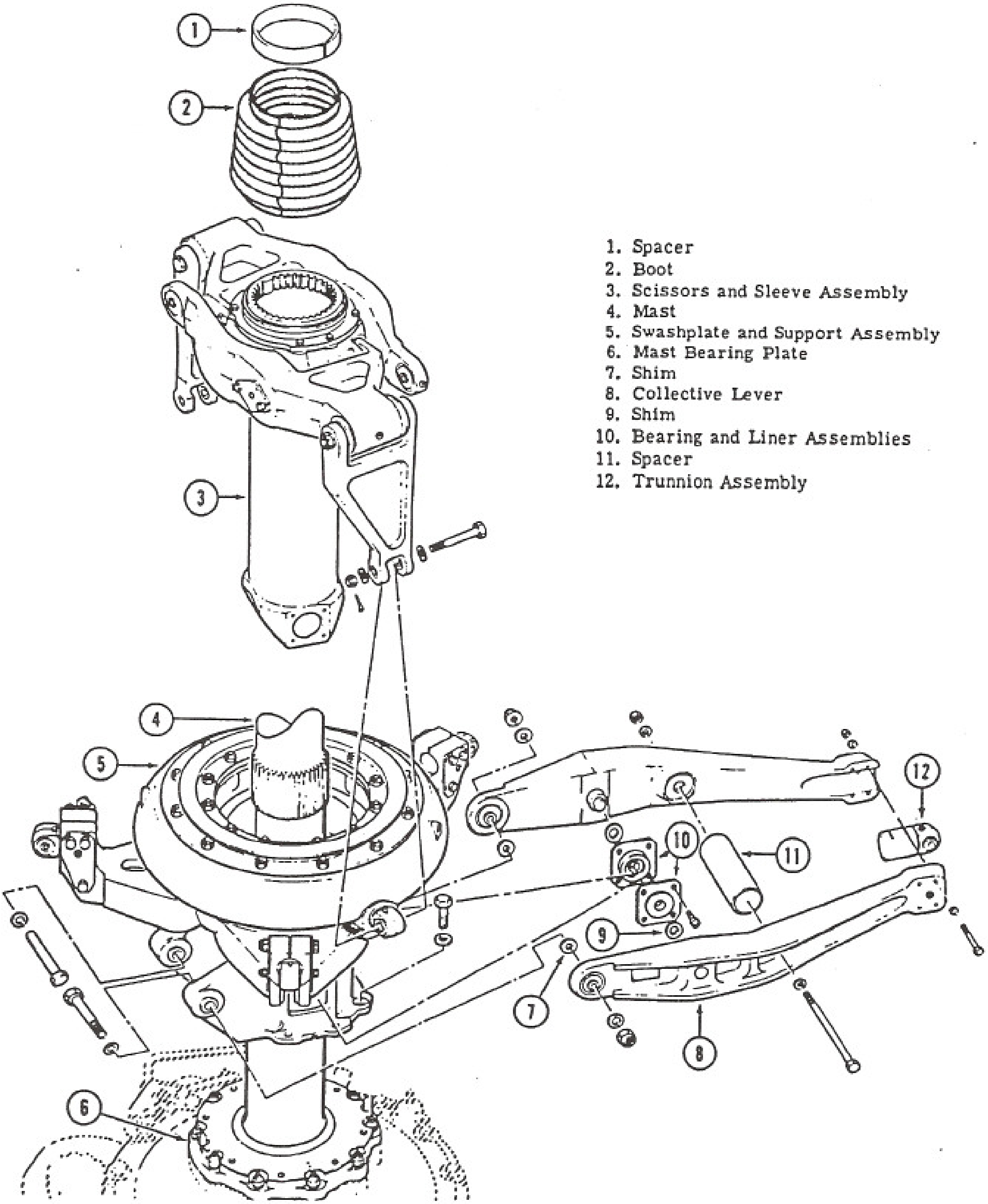
STABILIZER BAR DAMPERS

Two rotary viscous type dampers are mounted on a pair of adapters, which are attached on mast splines below main rotor. Levers on damper wingshafts are connected by control tubes to each side of stabilizer bar frame. Dampers are non-adjustable, being pre-set for required stiffness of action. Each has a filler plug for such occasional addition of hydraulic fluid, MIL-H-5606, as may be necessary due to minor leakage. A window is also provided through which an indicator pin and a cam mark can be viewed for a check of timing.



1. Damper Assembly
2. Retainer Rings (2)
3. Adapter
4. Lever Arm
5. Filler Plug

Stabilizer Bar Dampers



1. Spacer
2. Boot
3. Scissors and Sleeve Assembly
4. Mast
5. Swashplate and Support Assembly
6. Mast Bearing Plate
7. Shim
8. Collective Lever
9. Shim
10. Bearing and Liner Assemblies
11. Spacer
12. Trunnion Assembly

Swashplate and Collective Sleeve Installation

ROTATING CONTROLS

A swashplate and support assembly and a scissors and sleeve assembly are installed together and mounted around the mast on top of the transmission. The control unit thus formed transmits movements from the cyclic and collective control systems mounted in the cabin and fuselage to linkages which rotate with the main rotor. The swashplate is mounted on a universal support for tilt according to the position of the cyclic control stick. The collective sleeve moves vertically within the swashplate support, as actuated by the collective control stick. The combined effect on the scissor levers and upper linkage determined main rotor tilt and blade pitch.

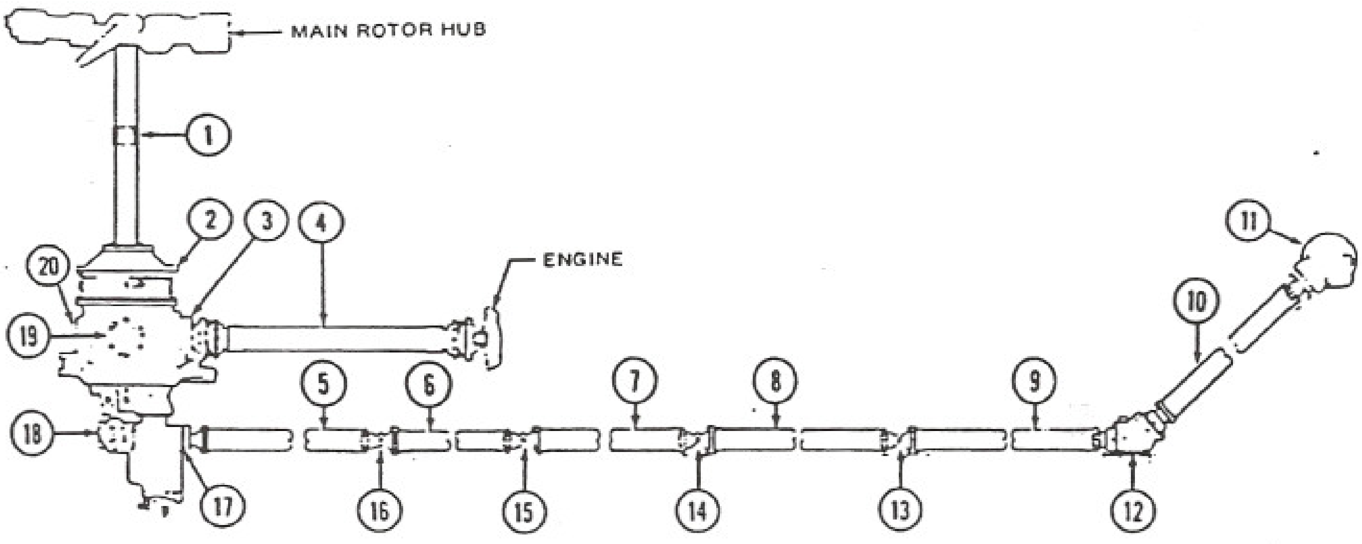
Notes

ANTI-TORQUE SYSTEM

The tail rotor drive system consists of six shafts, four bearing hanger assemblies, and two gear boxes connected in line between the transmission tail rotor drive quill and the tail rotor. Units of the system have mating curvic couplings, secured together by V-band clamp sets.

Bell

POWER TRAIN



1. Mast assembly
2. Transmission
3. Input quill
4. Engine to transmission driveshaft
5. Tail rotor driveshaft
6. Tail rotor driveshaft (short section)
7. Tail rotor driveshaft
8. Tail rotor driveshaft
9. Tail rotor driveshaft
10. Tail rotor driveshaft
11. Tail rotor gearbox
12. Intermediate gearbox
13. Hanger assembly
14. Hanger assembly
15. Hanger assembly
16. Hanger assembly
17. Tail rotor drive quill
18. Hydraulic pump and tachometer (system 1)
19. Cover
20. Hydraulic pump drive quill (system 2)

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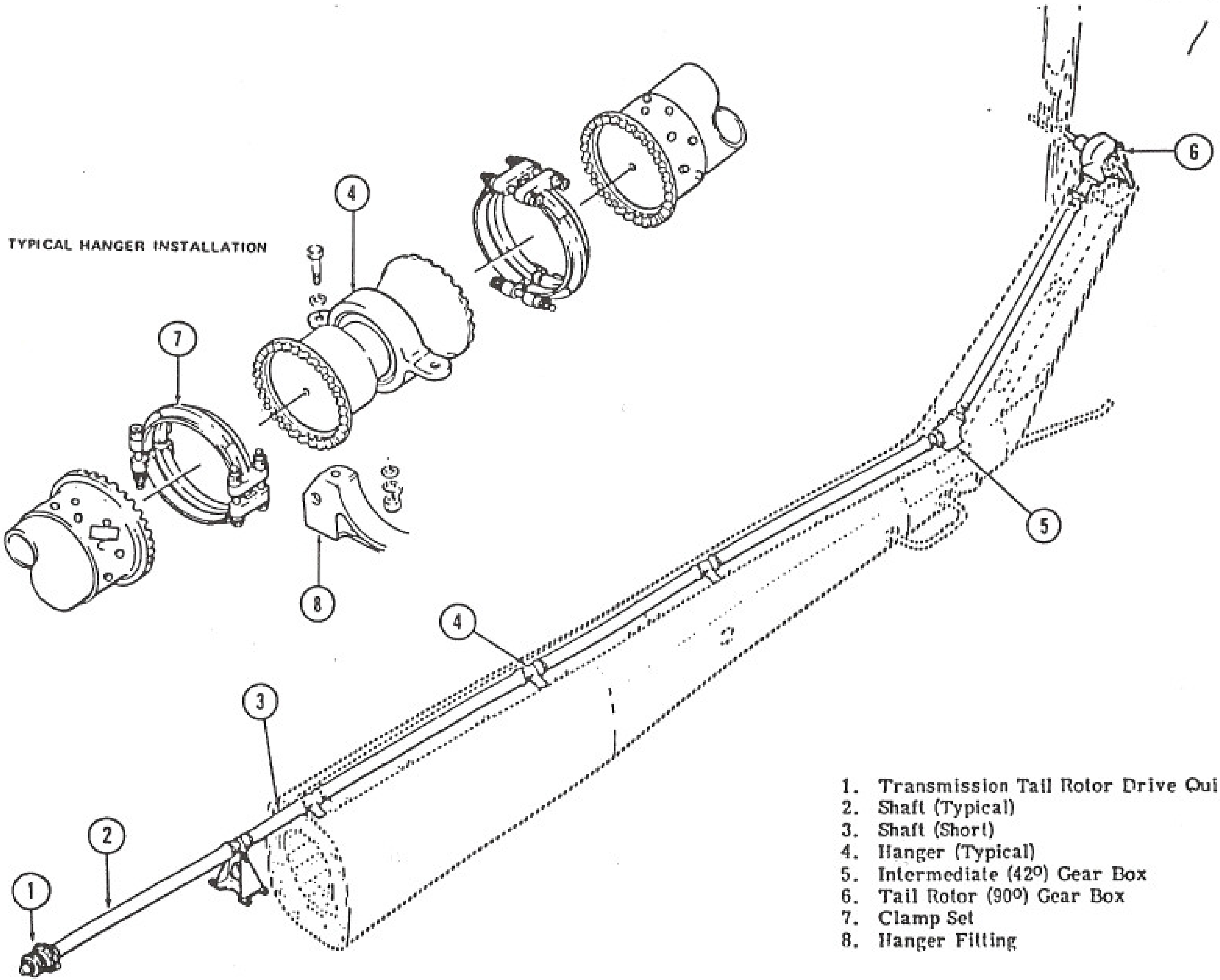
TAIL ROTOR DRIVESHAFT

Each shaft section is an aluminum alloy tube with a curvic coupling riveted to each end. Each shaft is dynamically balanced with a data plate and metal strips bonded at desired external locations. The forward shaft section extends through a tunnel beneath the powerplant, with ends connected by V-band clamps to mating splined couplings on the transmission tail rotor drive quill and on the forward bearing hanger. Other shaft sections are mounted in similar manner along the tail boom and vertical fin between the hangers and the gearboxes.



1. Transmission Tail Rotor Drive Quill
2. Shaft (Typical)
3. Shaft (Short)
4. Hanger (Typical)
5. Intermediate (42°) Gear Box
6. Tail Rotor (90°) Gear Box
7. Clamp Set
8. Hanger Fitting

Tail Rotor Drive Shaft Installation

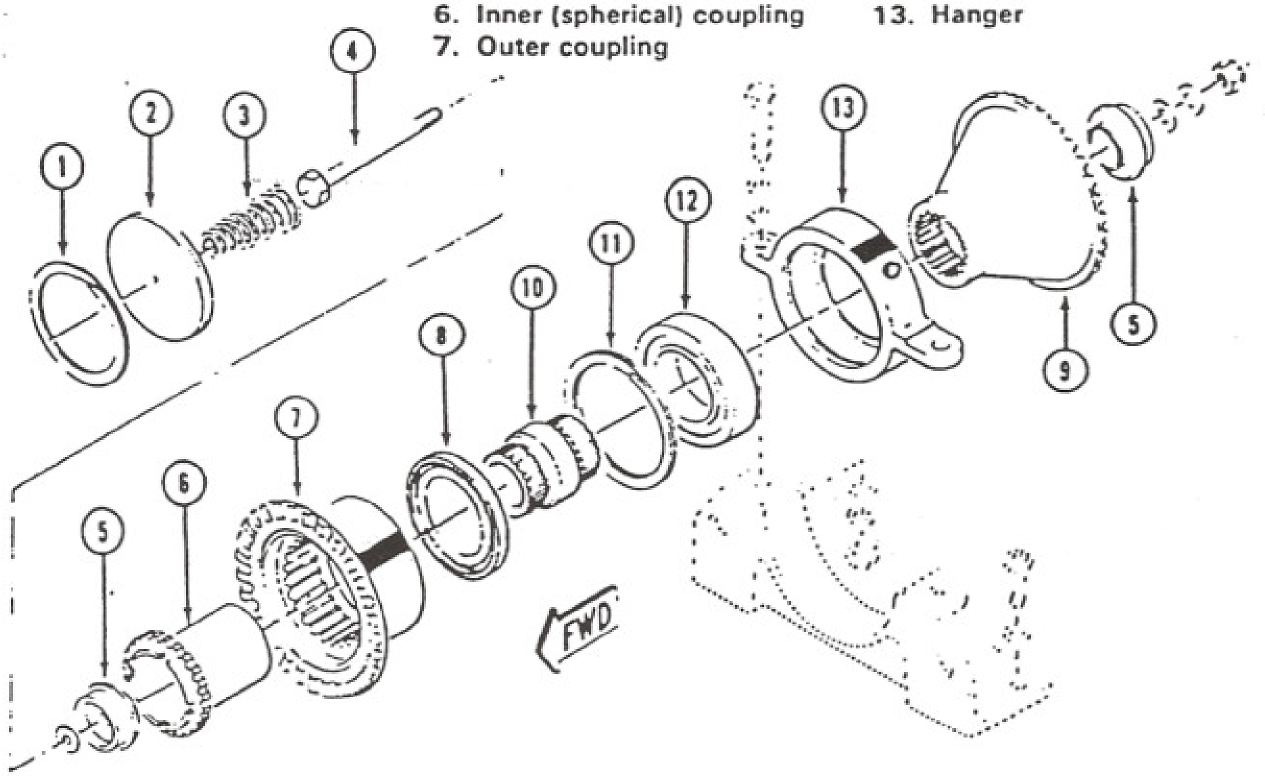
0.4
as QT
1650

90%

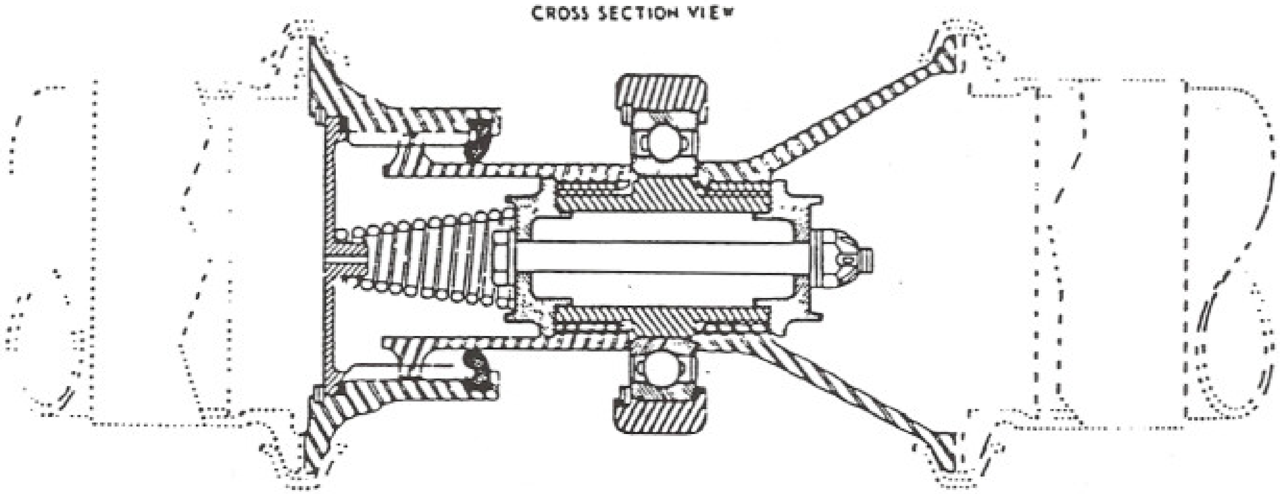
42/90
chip
master
caution

TAIL ROTOR DRIVESHAFT HANGER ASSEMBLY

1. Retaining ring
2. Cover plate
3. Spring
4. Retaining bolt
5. Retaining plates
6. Inner (spherical) coupling
7. Outer coupling
8. Seal
9. Rear coupling
10. Shaft
11. Retaining ring
12. Bearing
13. Hanger



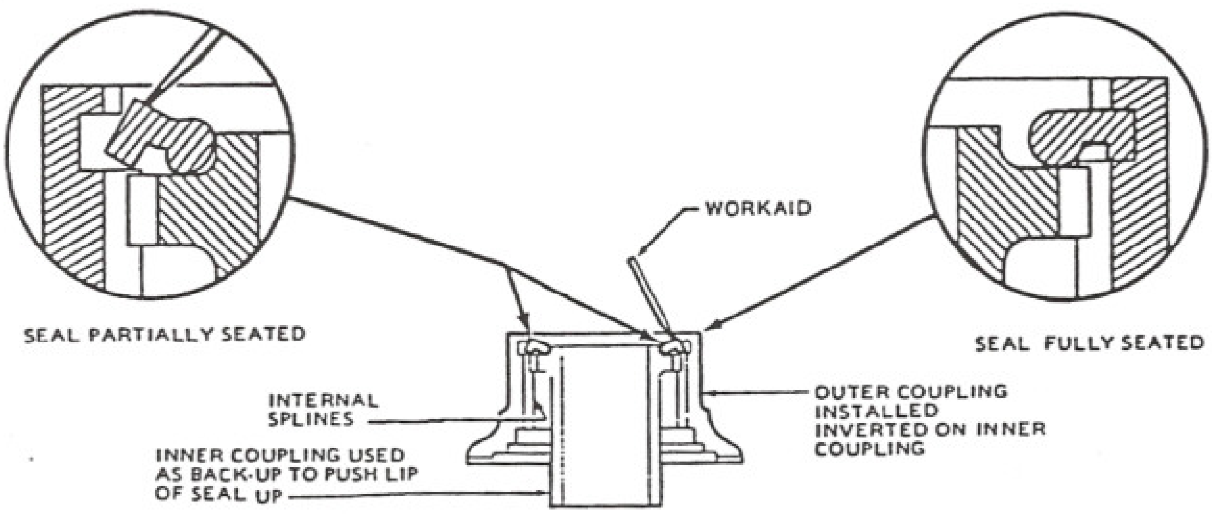
CROSS SECTION VIEW



DRIVESHAFT HANGERS

Four hanger assemblies are utilized for the drive shaft. Each assembly consists of couplings on a short splined shaft, mounted through a single-row sealed ball bearing in a ring-shaped hanger, equipped with two mounting lugs for attachment on a support fitting.

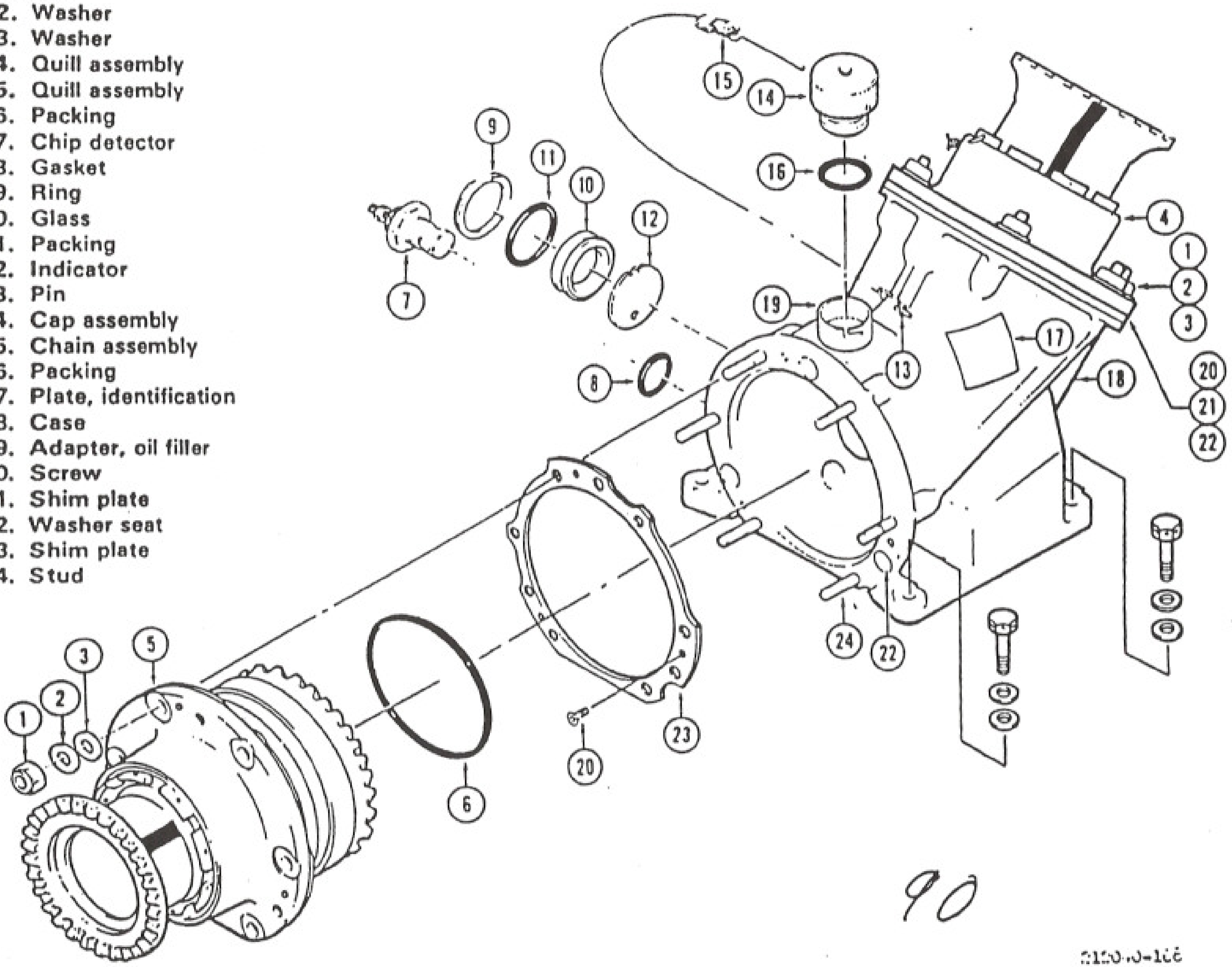
INSTALLING COUPLING SEAL



Bell

FORTY-TWO DEGREE GEARBOX

1. Nut
2. Washer
3. Washer
4. Quill assembly
5. Quill assembly
6. Packing
7. Chip detector
8. Gasket
9. Ring
10. Glass
11. Packing
12. Indicator
13. Pin
14. Cap assembly
15. Chain assembly
16. Packing
17. Plate, identification
18. Case
19. Adapter, oil filler
20. Screw
21. Shim plate
22. Washer seat
23. Shim plate
24. Stud



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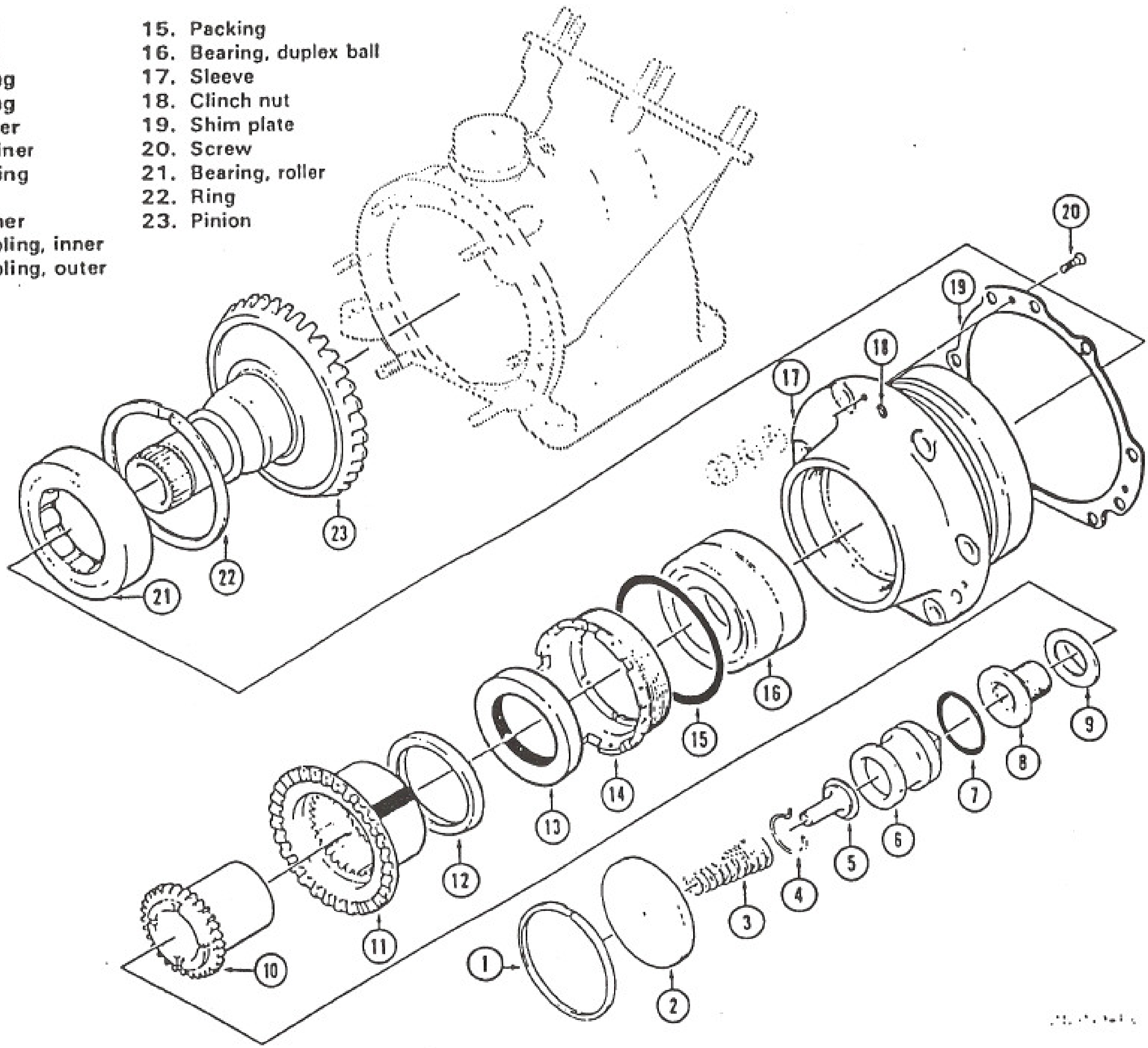
INTERMEDIATE (42°) GEARBOX

The forty-two degree gearbox is located on the tail boom, at the base of the vertical fin. This gearbox provides a forty-two degree change in direction of tail rotor drive shaft, with no speed change. The gearbox assembly consists of a case with a gear quill in each end. The case is fitted with a vented oil filler cap, an oil level sight gage and a drain plug equipped with a magnetic chip detector. Input and output quills have flexible couplings for attachment of drive shafts. Access is provided by a cover with quick-release fasteners.

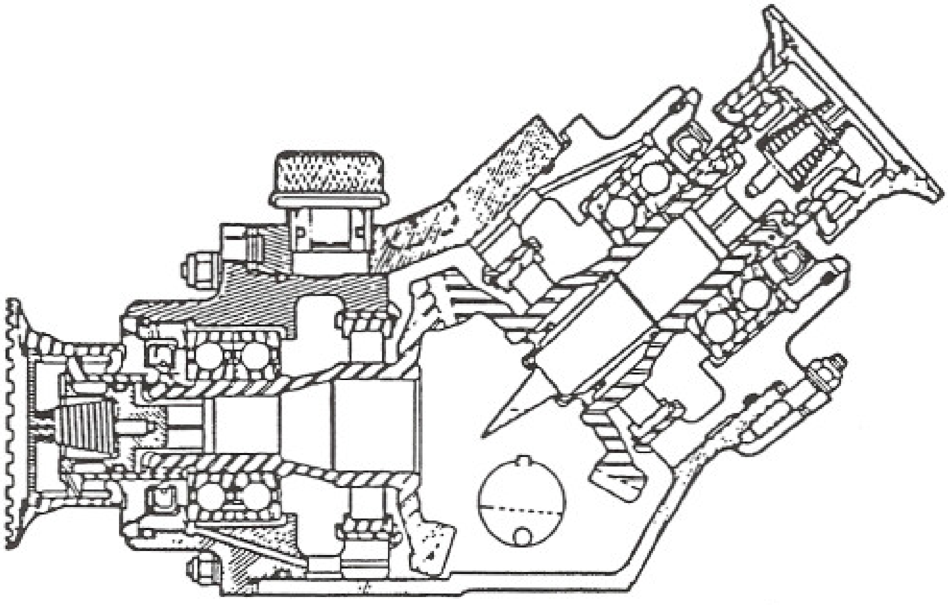
Bell

INPUT QUILL — FORTY-TWO DEGREE GEARBOX

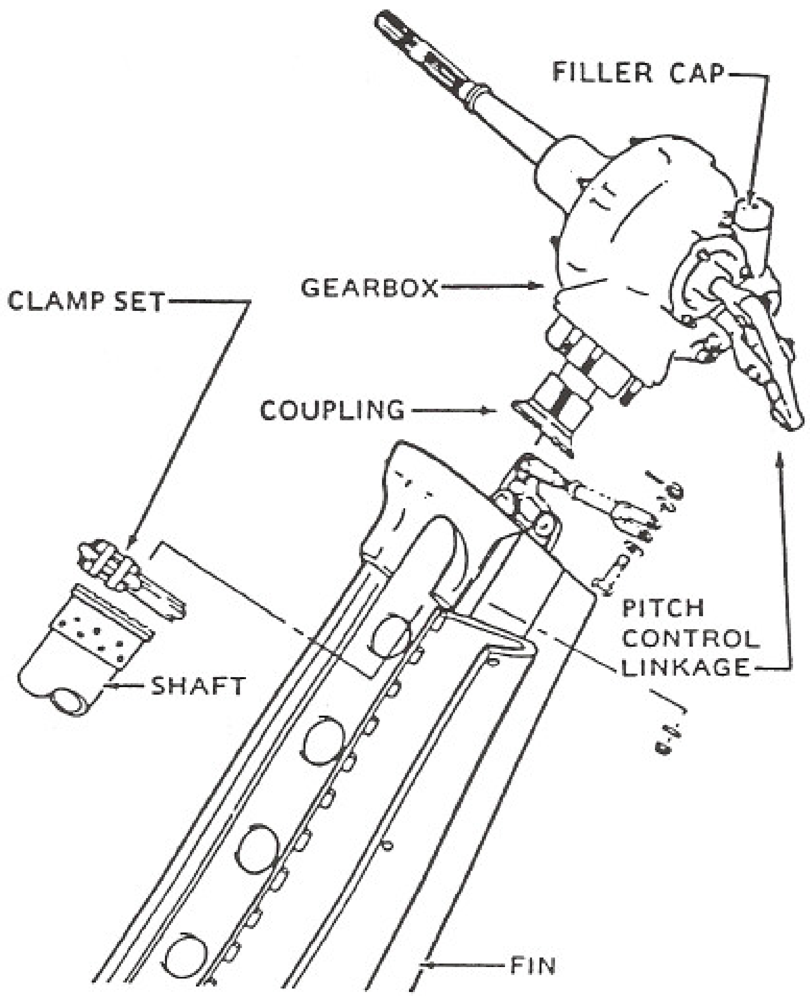
1. Ring
2. Plate
3. Spring
4. Spring
5. Spacer
6. Retainer
7. Packing
8. Bolt
9. Washer
10. Coupling, inner
11. Coupling, outer
12. Seal
13. Seal
14. Nut
15. Packing
16. Bearing, duplex ball
17. Sleeve
18. Clinch nut
19. Shim plate
20. Screw
21. Bearing, roller
22. Ring
23. Pinion



FORTY-TWO DEGREE GEARBOX CROSS SECTION



TAIL ROTOR GEARBOX INSTALLATION



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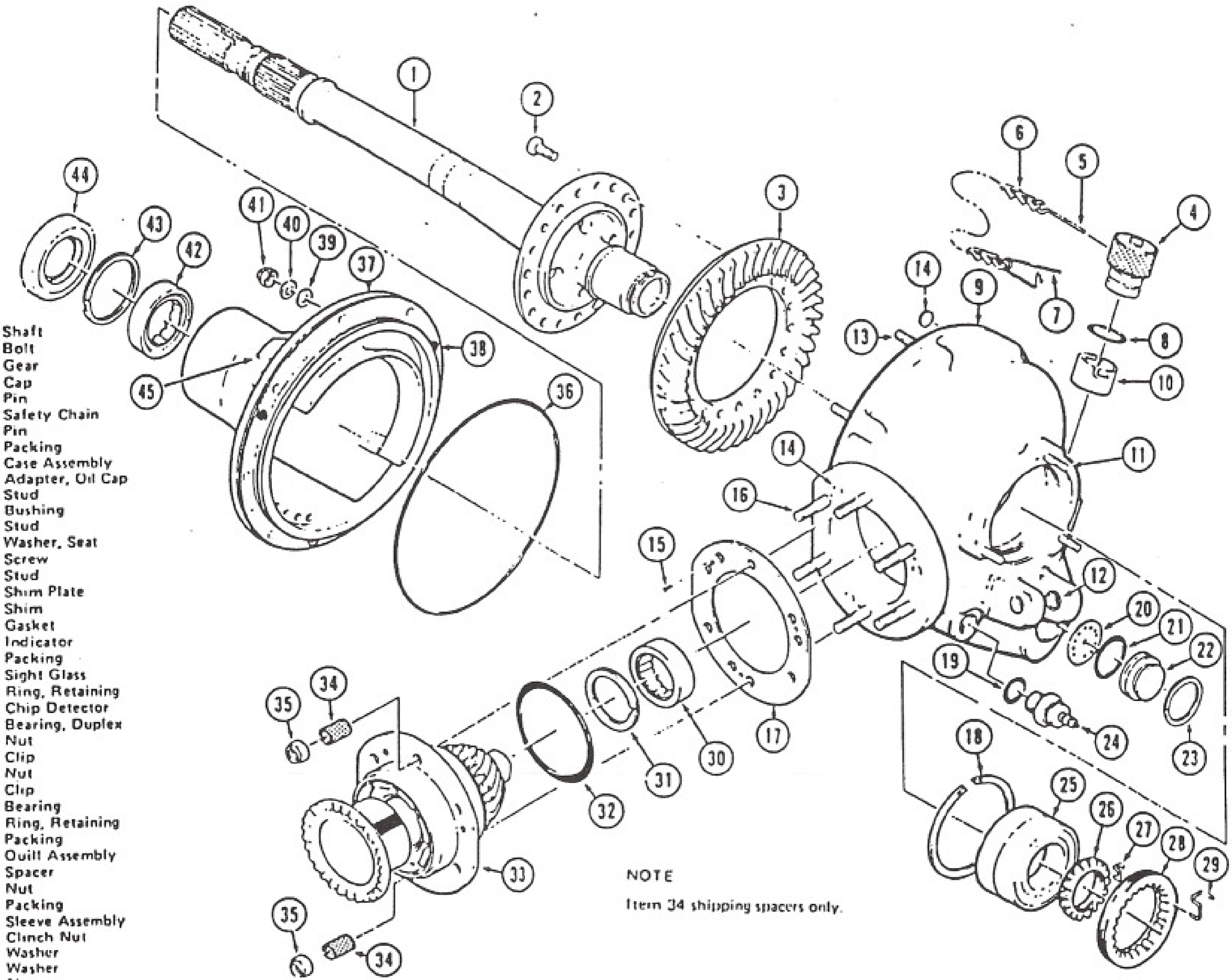
TAIL ROTOR GEARBOX

A gearbox at the top of the tail boom vertical fin provides a 90-degree change in the direction of drive and 2.59:1 speed reduction between the input drive pinion and the output shaft on which the tail rotor is mounted. The gearbox consists of mating input quill and output gear and shaft assemblies set into a gear case provided with a vented oil filler cap, an oil level sight gage, and a drain plug with a magnetic chip detector plug. The input quill has a flexible coupling for attachment of the driveshaft.

Bell

NINETY-DEGREE GEARBOX ASSEMBLY

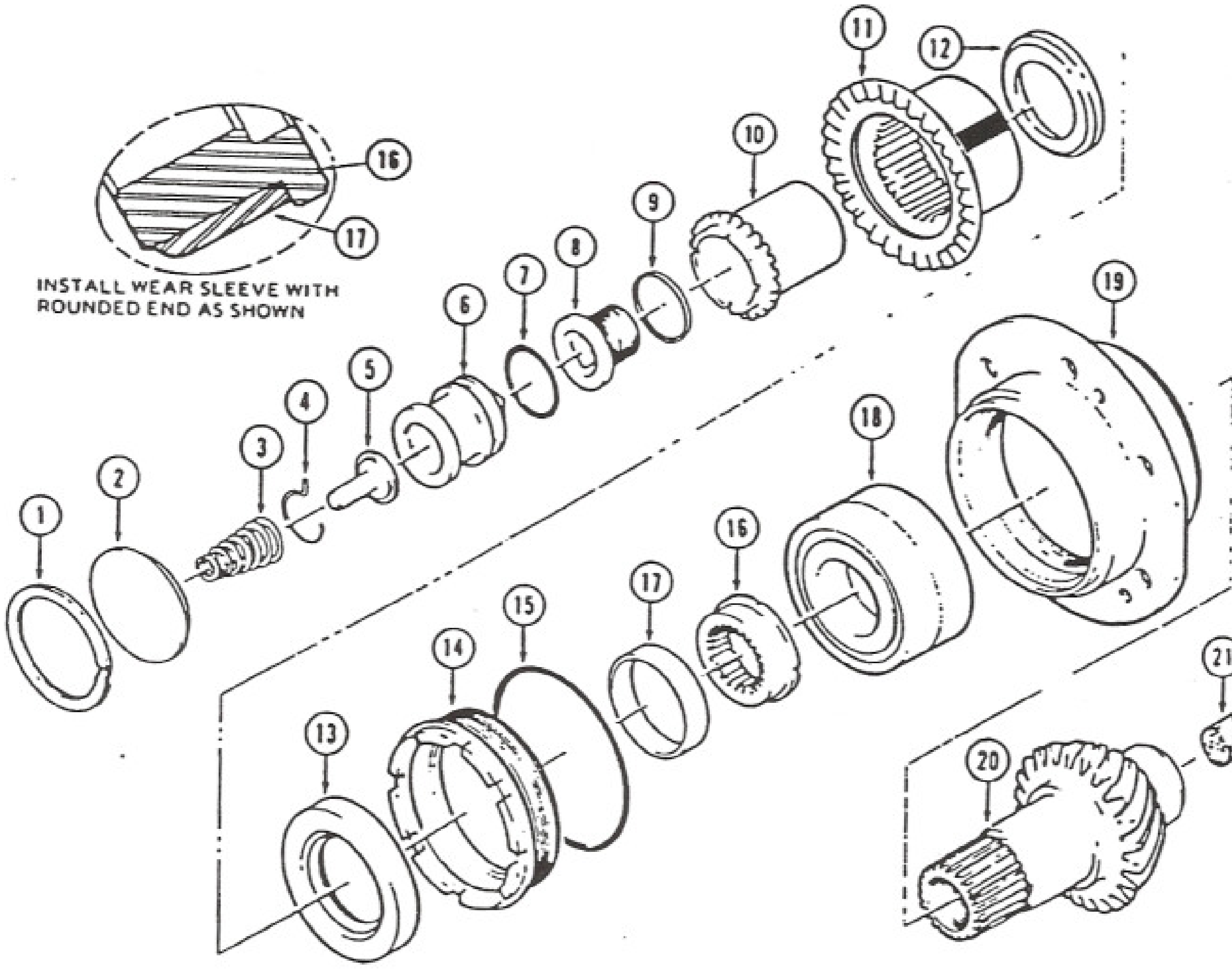


1. Shaft
2. Bolt
3. Gear
4. Cap
5. Pin
6. Safety Chain
7. Pin
8. Packing
9. Case Assembly
10. Adapter, Oil Cap
11. Stud
12. Bushing
13. Stud
14. Washer, Seat
15. Screw
16. Stud
17. Shim Plate
18. Shim
19. Gasket
20. Indicator
21. Packing
22. Sight Glass
23. Ring, Retaining
24. Chip Detector
25. Bearing, Duplex
26. Nut
27. Clip
28. Nut
29. Clip
30. Bearing
31. Ring, Retaining
32. Packing
33. Quill Assembly
34. Spacer
35. Nut
36. Packing
37. Sleeve Assembly
38. Clinch Nut
39. Washer
40. Washer
41. Nut
42. Bearing
43. Ring Retaining
44. Seal
45. Plate Identification

NOTE

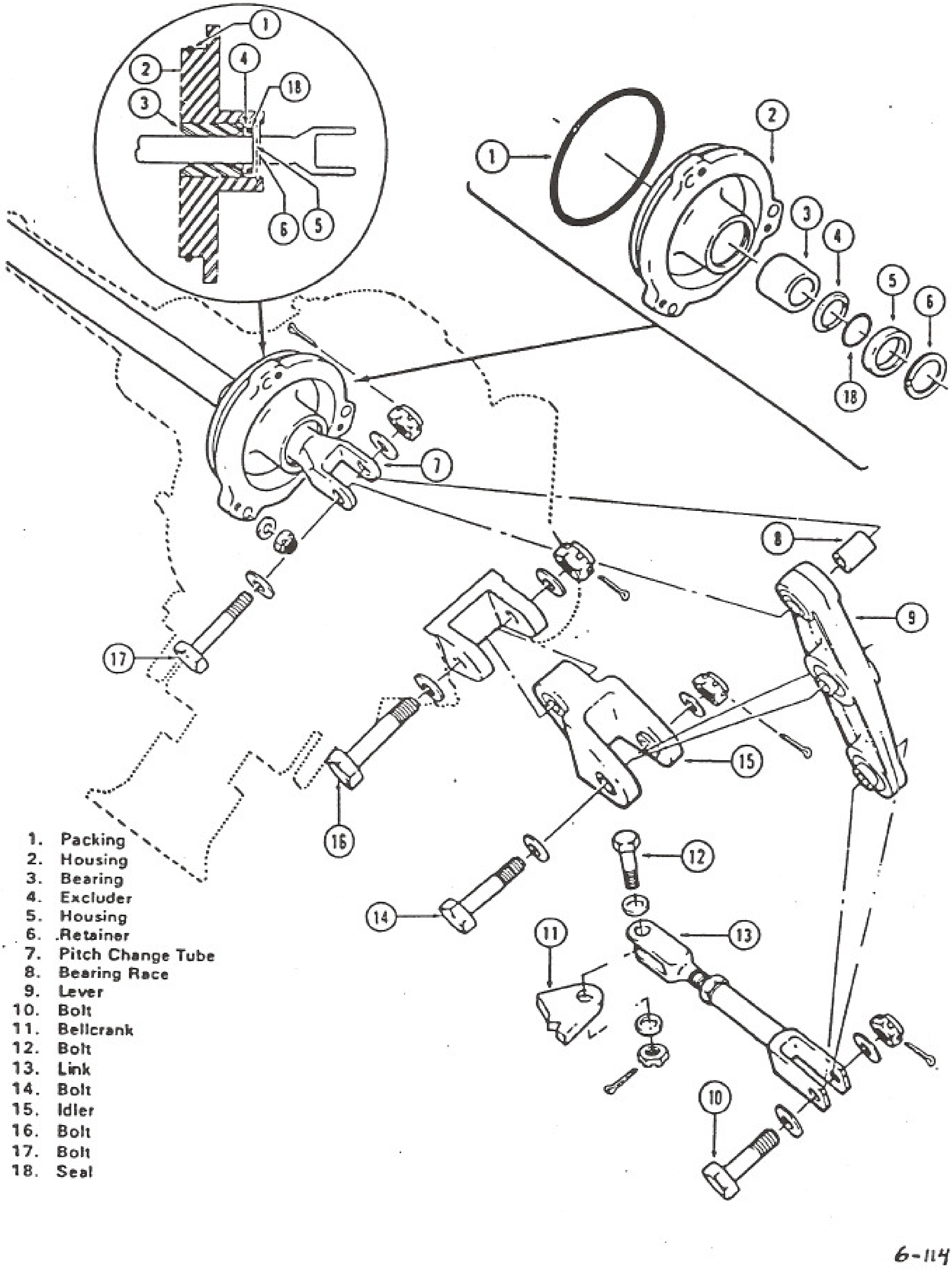
Item 34 shipping spacers only.

90° GEARBOX INPUT QUILL ASSEMBLY



1. Ring retainer
2. Plate
3. Spring centering
4. Spring lock
5. Spacer
6. Retainer
7. Packing
8. Bolt
9. Washer
10. Coupling, inner
11. Coupling, outer
12. Seal
13. Seal
14. Nut
15. Packing
16. Spacer
17. Sleeve, wear
18. Bearing duplex
19. Sleeve
20. Pinion
21. Cork plug

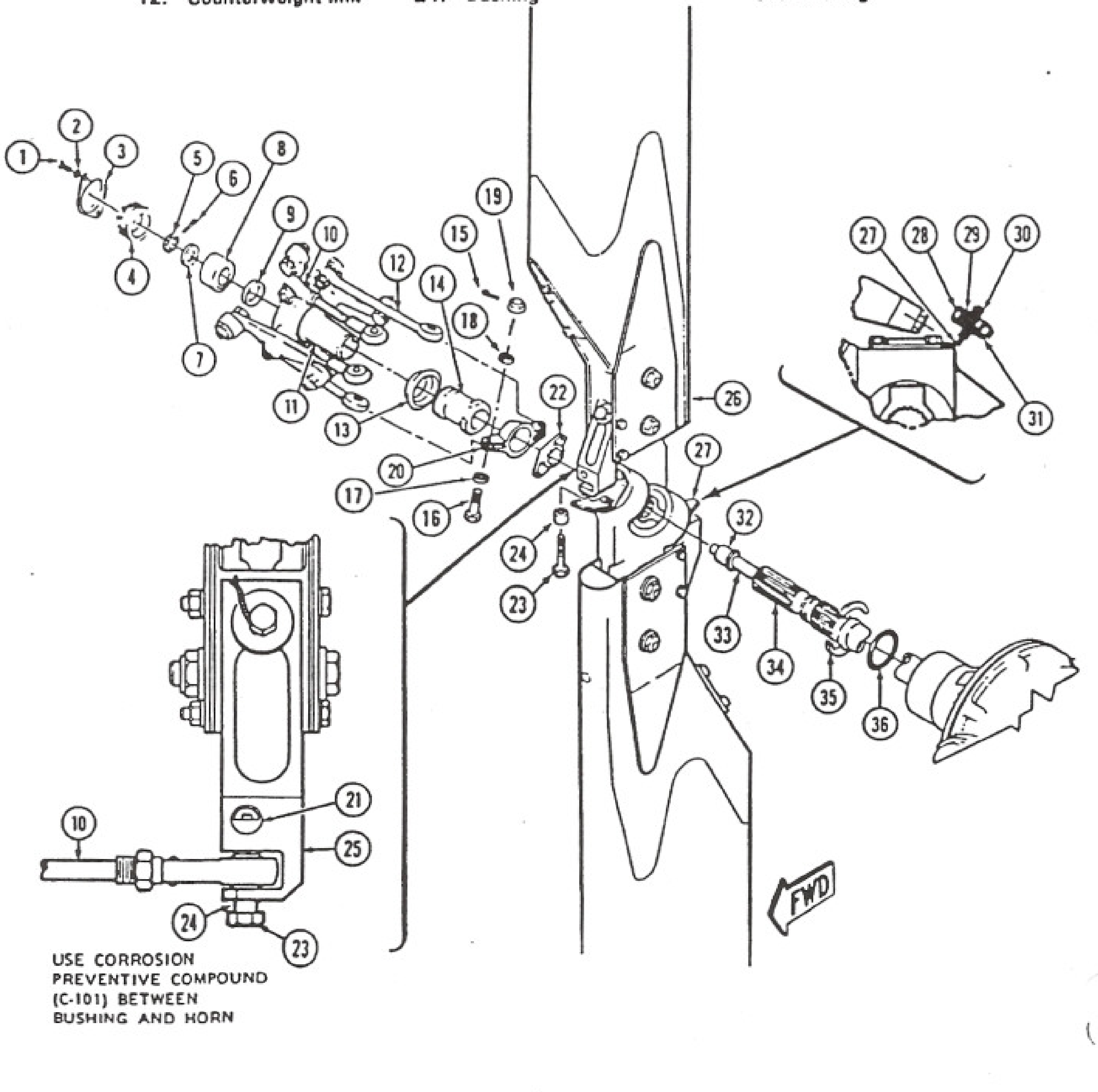
ANTI-TORQUE CONTROLS PITCH CHANGE MECHANISM



1. Packing
2. Housing
3. Bearing
4. Excluder
5. Housing
6. Retainer
7. Pitch Change Tube
8. Bearing Race
9. Lever
10. Bolt
11. Bellcrank
12. Bolt
13. Link
14. Bolt
15. Idler
16. Bolt
17. Bolt
18. Seal

TAIL ROTOR INSTALLATION

1. Screw
2. Washer
3. Lock
4. Retainer
5. Nut
6. Cotter pin
7. Washer
8. Bearing
9. Special washer
10. Pitch Link
11. Crosshead
12. Counterweight link
13. Shield
14. Retaining nut
15. Cotter pin
16. Bolt
17. Washer
18. Washer
19. Nut
20. Counterweight support
21. Barrel nut and retainer
22. Stop
23. Bolt
24. Bushing
25. Pitch horn
26. Hub and blade
27. Balance bracket
28. Bolt
29. Washer
30. Washer
31. Nut
32. Sleeve
33. Pitch change control tube
34. Gearbox output shaft
35. Split cone set
36. Packing

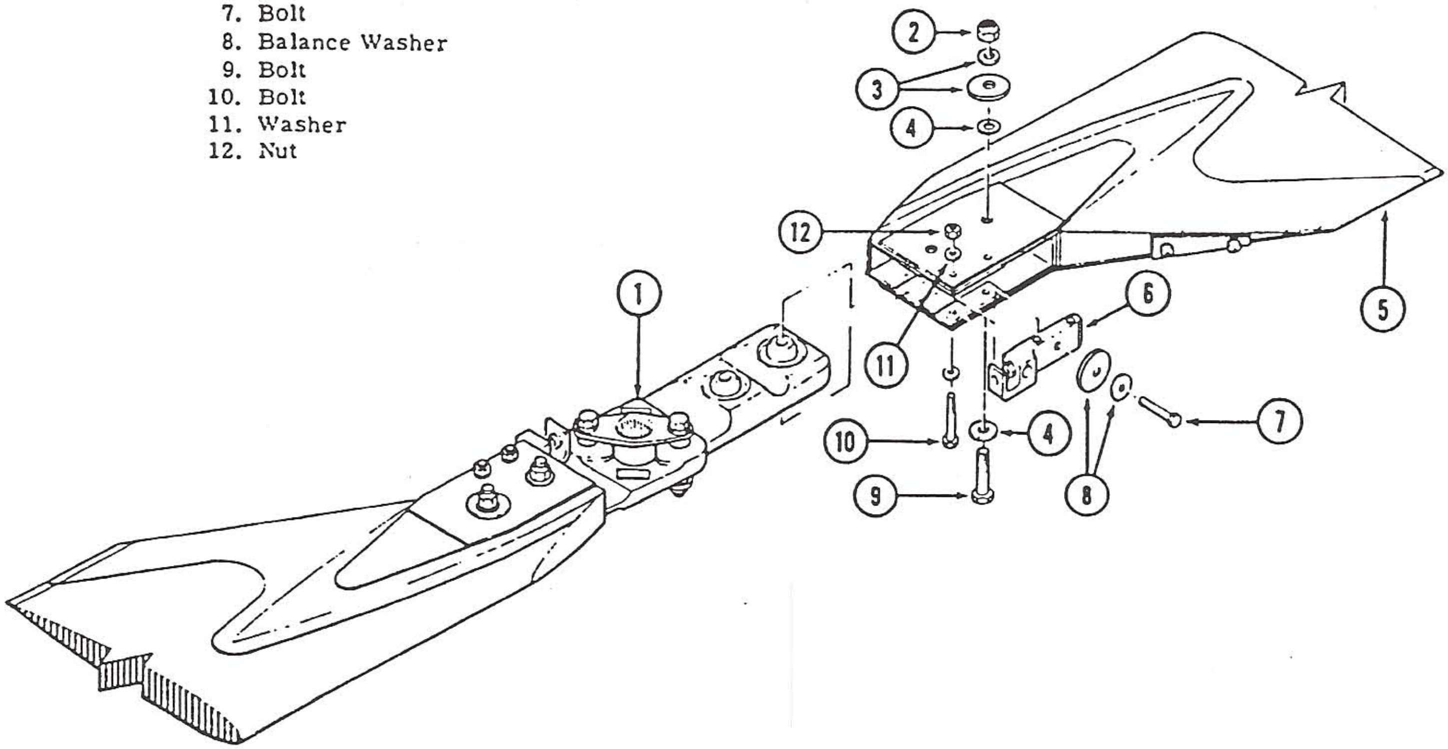


TAIL ROTOR GROUP

DESCRIPTION

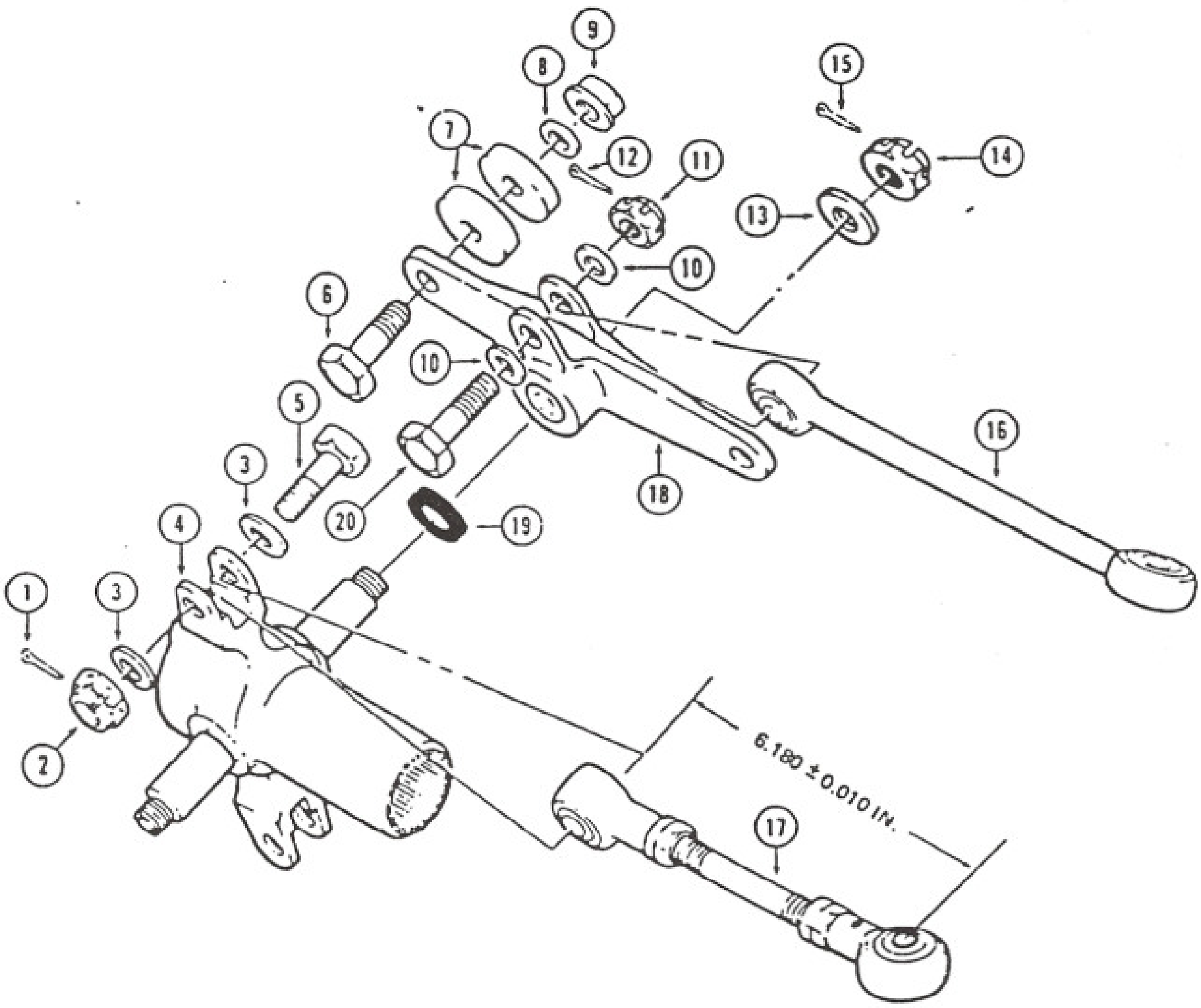
A single two-blade controllable pitch tail rotor is located on the right side of the tail rotor gear box. It is composed of two assemblies, the hub and the blades, and is driven through the tail rotor gear box. Blades are all metal construction and are attached by bolts to pitch change bearings in the hub yoke. The tail rotor hub is delta hinge mounted to provide for automatic equilization of thrust on advancing and retreating blades. Control links provide equal and simultaneous pitch change to both blades. The tail rotor counteracts torque of the main rotor and provides directional heading control.

1. Hub
2. Nut
3. Balance Washer
4. Washer
5. Blade
6. Pitch Horn
7. Bolt
8. Balance Washer
9. Bolt
10. Bolt
11. Washer
12. Nut



Tail Rotor Hub and Blade Assembly

TAIL ROTOR CROSSHEADS CONTROLS

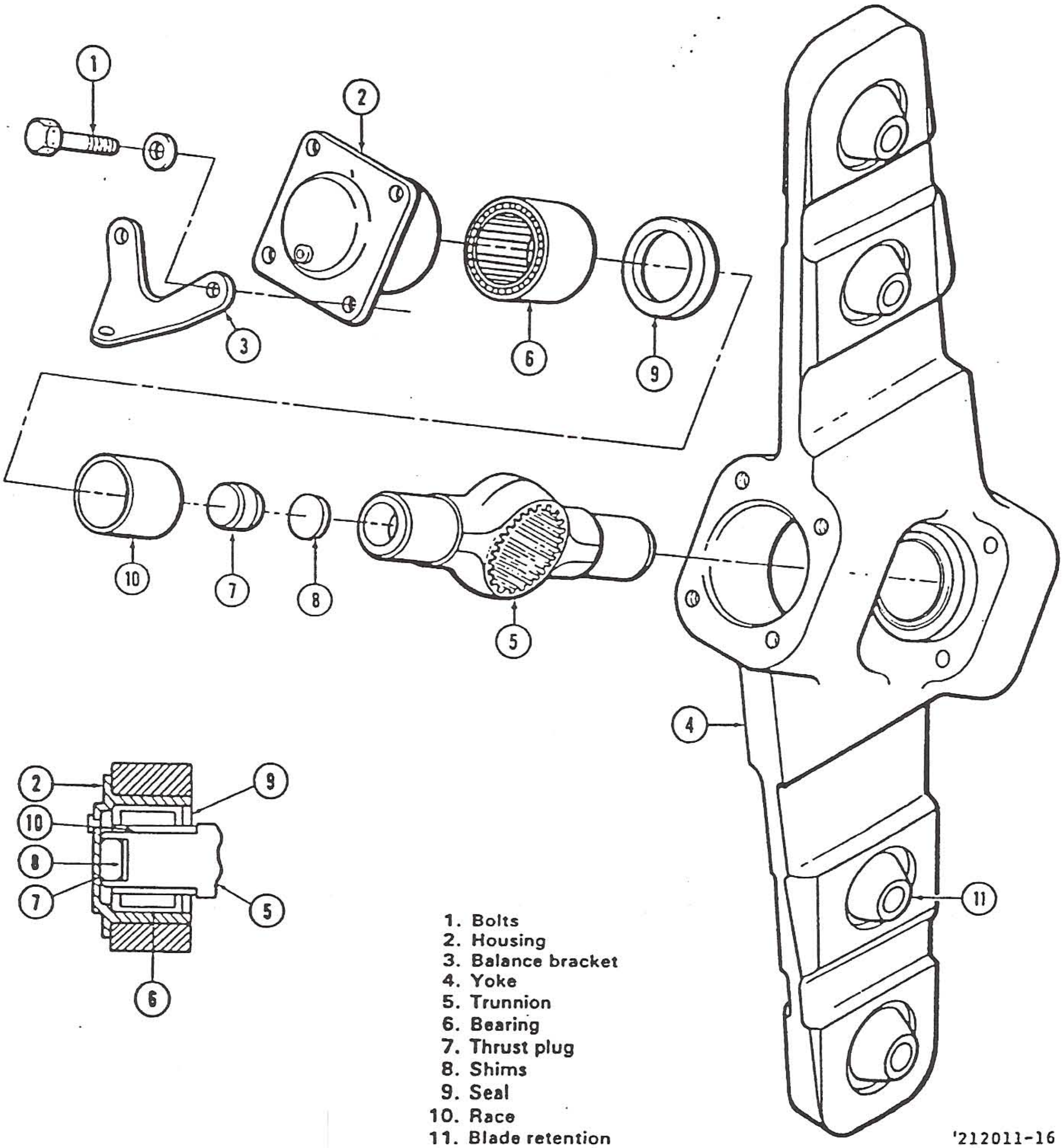


1.	Cotter Pin	11.	Nut
2.	Nut	12.	Cotter
3.	Washer	13.	Washer
4.	Crosshead	14.	Nut
5.	Bolt	15.	Cotter Pin
6.	Bolt	16	Counterweight Link
*7.	Weight	17	Pitch Link
8.	Washer	18.	Bellcrank
9.	Nut	19.	Washer
10	Washer	20.	Bolt

See TB 412-88-65 for correct tail rotor counterweight bellcrank installation.

*NOTE There must be two weights at each of the four locations for a total of eight weights

TAIL ROTOR HUB



1. Bolts
2. Housing
3. Balance bracket
4. Yoke
5. Trunnion
6. Bearing
7. Thrust plug
8. Shims
9. Seal
10. Race
11. Blade retention bearing

'212011-16

From the dual hydraulic servo actuator, mounted in the aft left corner of the pylon area, the mechanical linkage of the flight control coupling system transmits collective pitch change to the cyclic and directional control systems.

TAIL ROTOR CONTROL SYSTEM

The tail rotor control system transmits control movement from the pilot and co-pilot's control pedals through mechanical linkage to the tail rotor mounted on the top right side of the vertical fin. The system includes, connected in series, control pedals, adjustor assembly, scissor bellcrank, series actuator, hydraulic servo actuator and a crosshead assembly. A rotary actuator and force gradient are connected in parallel with the mechanical linkage. The adjustor assembly provides fore and aft adjustment of the pedals for pilot/co-pilot comfort. The rotary actuator, attached at the adjustor assembly, transmits control movement commands, through the force gradient, from the AFCS to the mechanical linkage. With the AFCS dis-engaged the rotary actuator/force gradient provide a force trim for artificial control fee. The scissor bellcrank introduces the corrective compensation into the anti-torque system as a result of collective pitch change. The series actuator, in addition to the rotary actuator, transmits control movement commands from the AFCS to the mechanical linkage of the tail rotor system. The hydraulic servo actuator reduces the effort required for tail rotor control movement. The crosshead assembly, mounted on the output mast of the 90 degree gear box, transmits control movements to the tail rotor. The counter weights, mounted on the crosshead assembly, reduce the effort required for tail rotor control movement without hydraulic assist.

FLIGHT CONTROL COUPLING SYSTEM

To reduce pilot work load during climbs and descents the flight control coupling system introduces corrective compensation into the mechanical linkage of the cyclic and tail rotor controls as a function of collective pitch change. The amount of corrective input varies with the amount of collective pitch change, airspeed, gross weight and center of gravity. With full compensation, an increase/decrease of collective pitch, within the capabilities of the system, will not require a corrective input to the cyclic and directional controls by the pilot thereby reducing his work load. The mechanical linkage of the flight control coupling system is comprised of push-pull tubes, bellcranks, torque tubes and scissor bellcranks. By an attachment to the collective pitch hydraulic servo actuator a change in collective pitch is transmitted to a torque tube which introduces motion into the three sets of scissor bellcranks, fore-aft and lateral cyclic and tail rotor control systems. Normal pilot inputs rotate the complete scissor bellcrank while inputs from the coupling system rotates only one arm to introduce the properly porportioned motion to the respective flight control.

FLIGHT CONTROLS

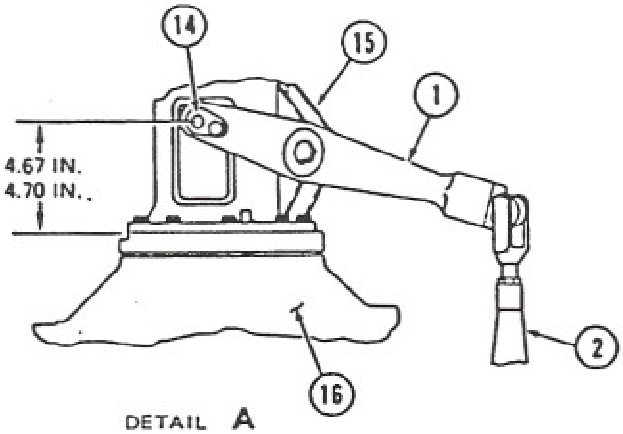
Hydraulic boosted mechanical linkage systems, actuated from the pilots station, are used to control the helicopters attitude and direction of flight. An optional dual controls kit and copilot instrument kit may be installed to provide a copilot station.

The controls include the collective and cyclic systems to the main rotor and the anti-torque system to the tail rotor. The tailboom mounted elevator aids in controlability and is controlled by airspeed and a spring loaded tube assembly.

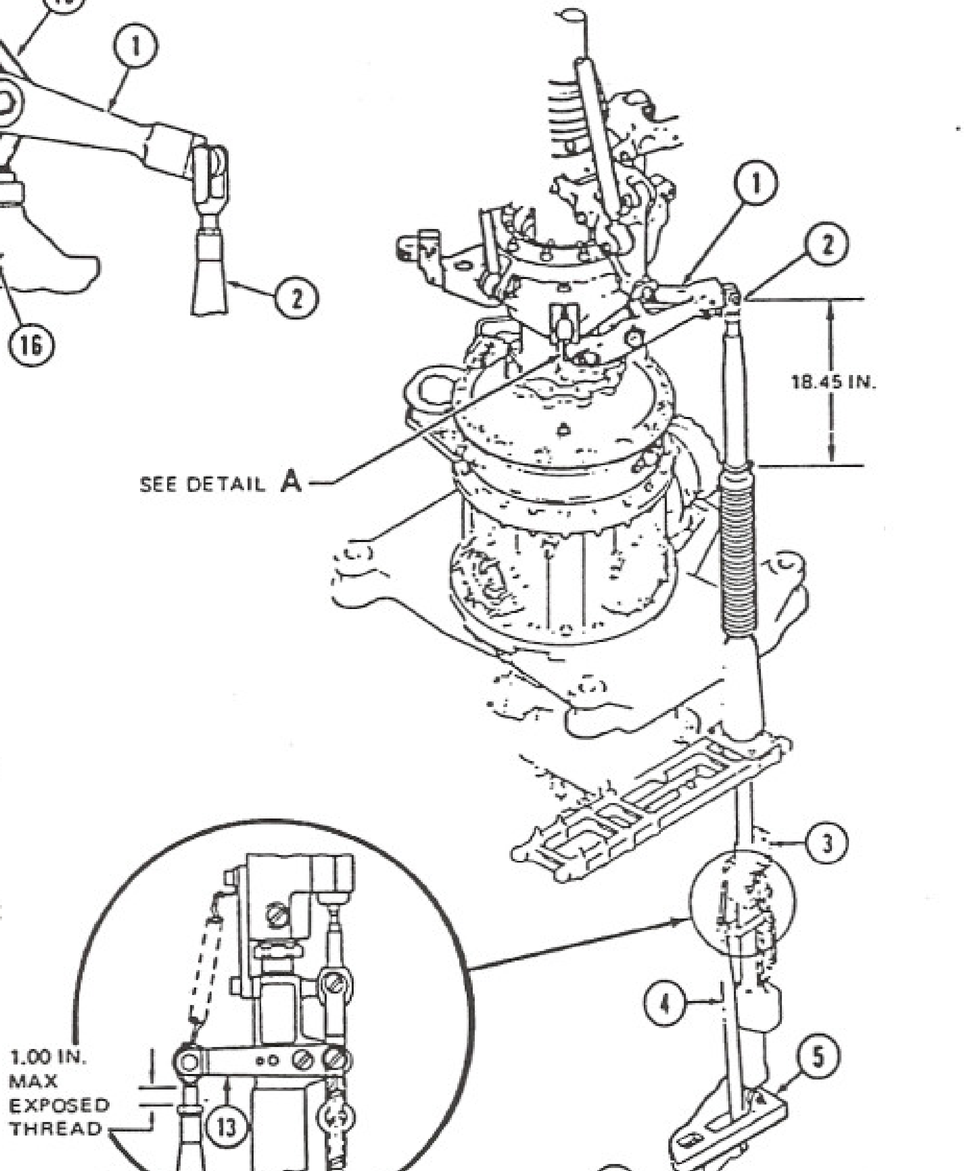
An Automatic Flight Control System (AFCS) is integrated into the cyclic and anti-torque controls to provide stability augmentation and attitude retention. An optionally available Flight Director Kit provides automatic flight path control.

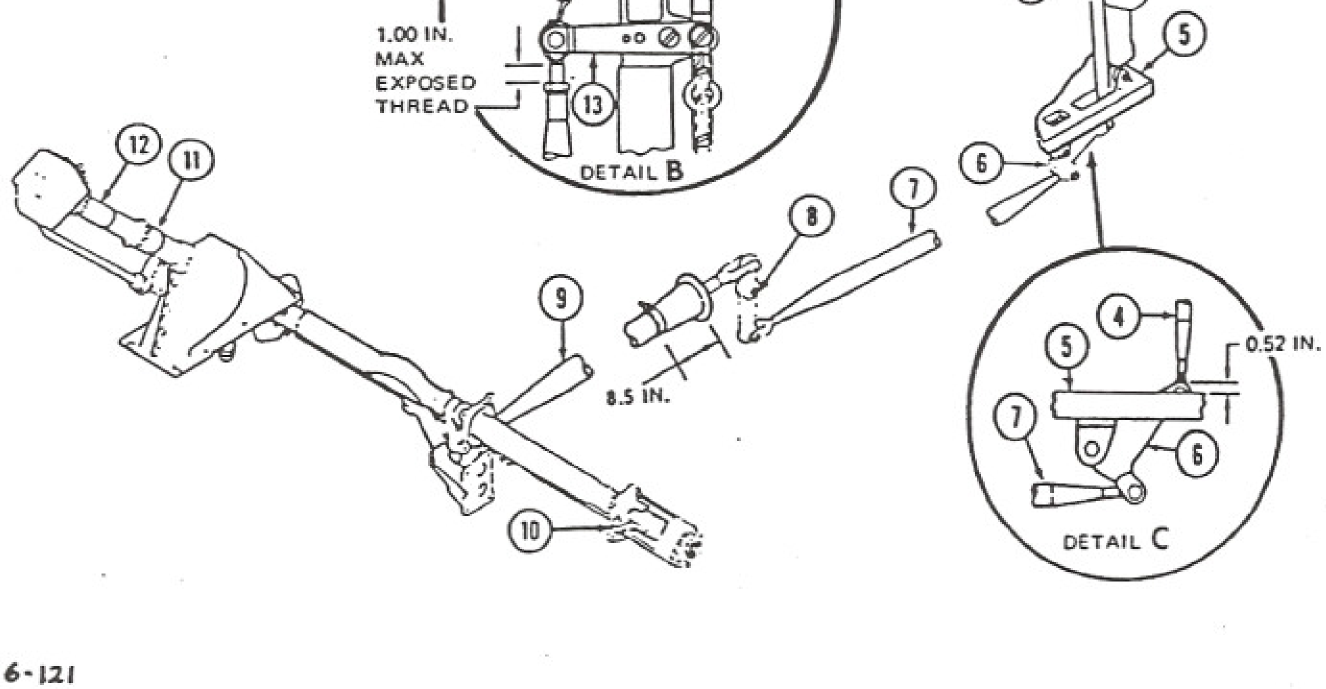
Bell

COLLECTIVE CONTROL SYSTEM



1. Collective lever
2. Flight control tube
3. Cylinder
4. Flight control tube
5. Support
6. Bellcrank
7. Flight control tube
8. Bellcrank
9. Flight control tube
10. Friction clamp
11. Friction adjustment
12. Pilot collective control stick
13. Actuator lever
14. Pin
15. Swashplate support
16. Transmission





COLLECTIVE CONTROL SYSTEM

The collective control system consists of the pilots stick attached to a jackshaft, a series of push-pull tubes and bellcranks to a dual hydraulic servo actuator connected to the collective lever of the main rotor controls. Movement of the controls causes the pitch of the four main rotor blades to increase or decrease collectively causing the helicopter to ascend, descend or remain at a constant altitude.

At the left end of the jackshaft there is a minimum friction clamp and provisions for installation of a copilots stick, a part of the dual controls kit.

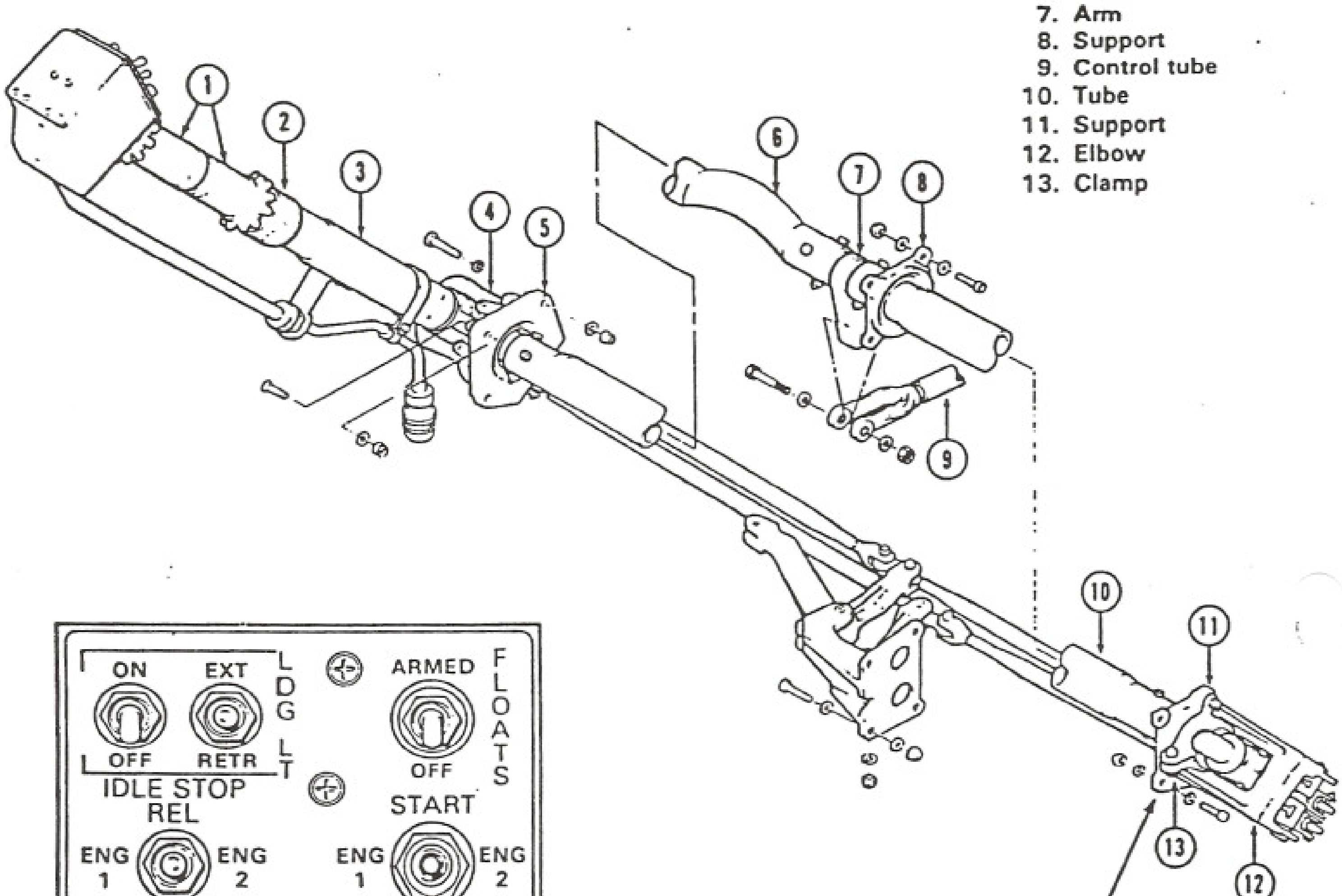
The dual servo actuator provides a hydraulic boost to the controls and prevents rotor feedback forces from moving the controls.

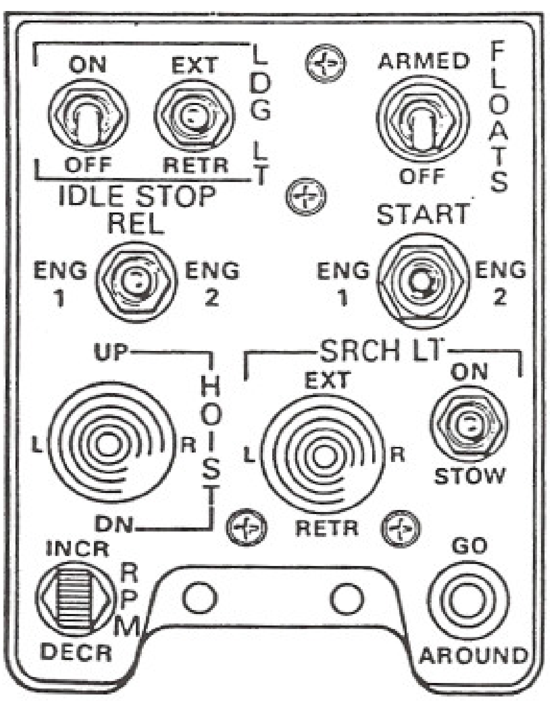
When the Flight Director Kit is installed, a transducer is connected to the jackshaft to sense collective control movement.

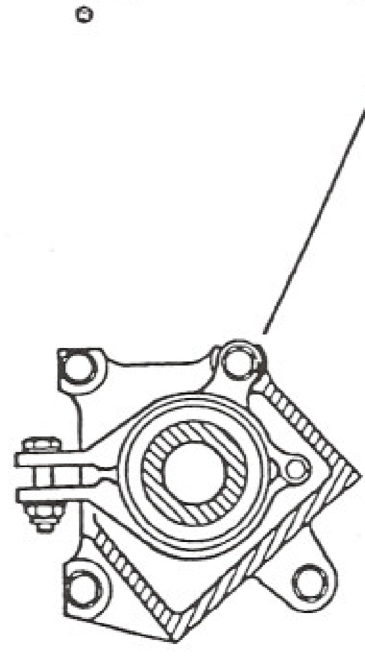
COLLECTIVE STICK AND JACKSHAFT

See ASB 412-87-60 for inspection of collective stick.

1. Throttle grip
2. Friction nut
3. Stick
4. Elbow
5. Housing
6. Tube
7. Arm
8. Support
9. Control tube
10. Tube
11. Support
12. Elbow
13. Clamp



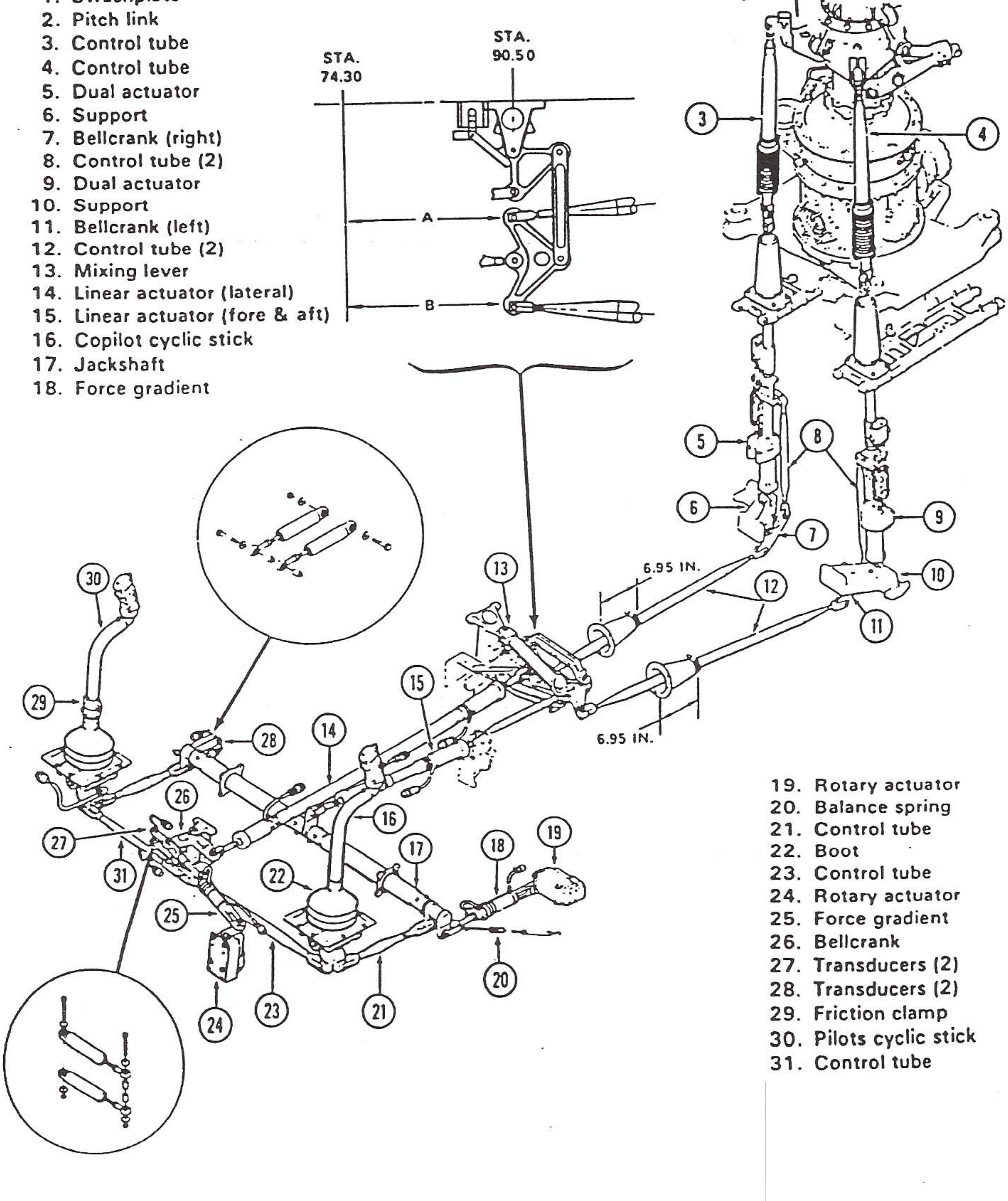




Collective
Yaw coupling.
up collective suppli
Input to T/R.

CYCLIC CONTROL SYSTEM

1. Swashplate
2. Pitch link
3. Control tube
4. Control tube
5. Dual actuator
6. Support
7. Bellcrank (right)
8. Control tube (2)
9. Dual actuator
10. Support
11. Bellcrank (left)
12. Control tube (2)
13. Mixing lever
14. Linear actuator (lateral)
15. Linear actuator (fore & aft)
16. Copilot cyclic stick
17. Jackshaft
18. Force gradient



19. Rotary actuator
20. Balance spring
21. Control tube
22. Boot
23. Control tube
24. Rotary actuator
25. Force gradient
26. Bellcrank
27. Transducers (2)
28. Transducers (2)
29. Friction clamp
30. Pilots cyclic stick
31. Control tube

CYCLIC CONTROL SYSTEM

The cyclic control system linkage transmits cyclic stick movement to the main rotor controls causing the swashplate and rotor to tilt in the desired direction of flight. The cyclic stick actuates two systems of linkage, fore-aft and lateral, which are independent systems to a mixing lever assembly. From the mixing lever assembly to the swashplate horns, the linkage is not considered separate as to effect. AFCS related components including a linear actuator, two transducers and a force gradient assembly with rotary actuator are connected into each the fore-aft and lateral systems.

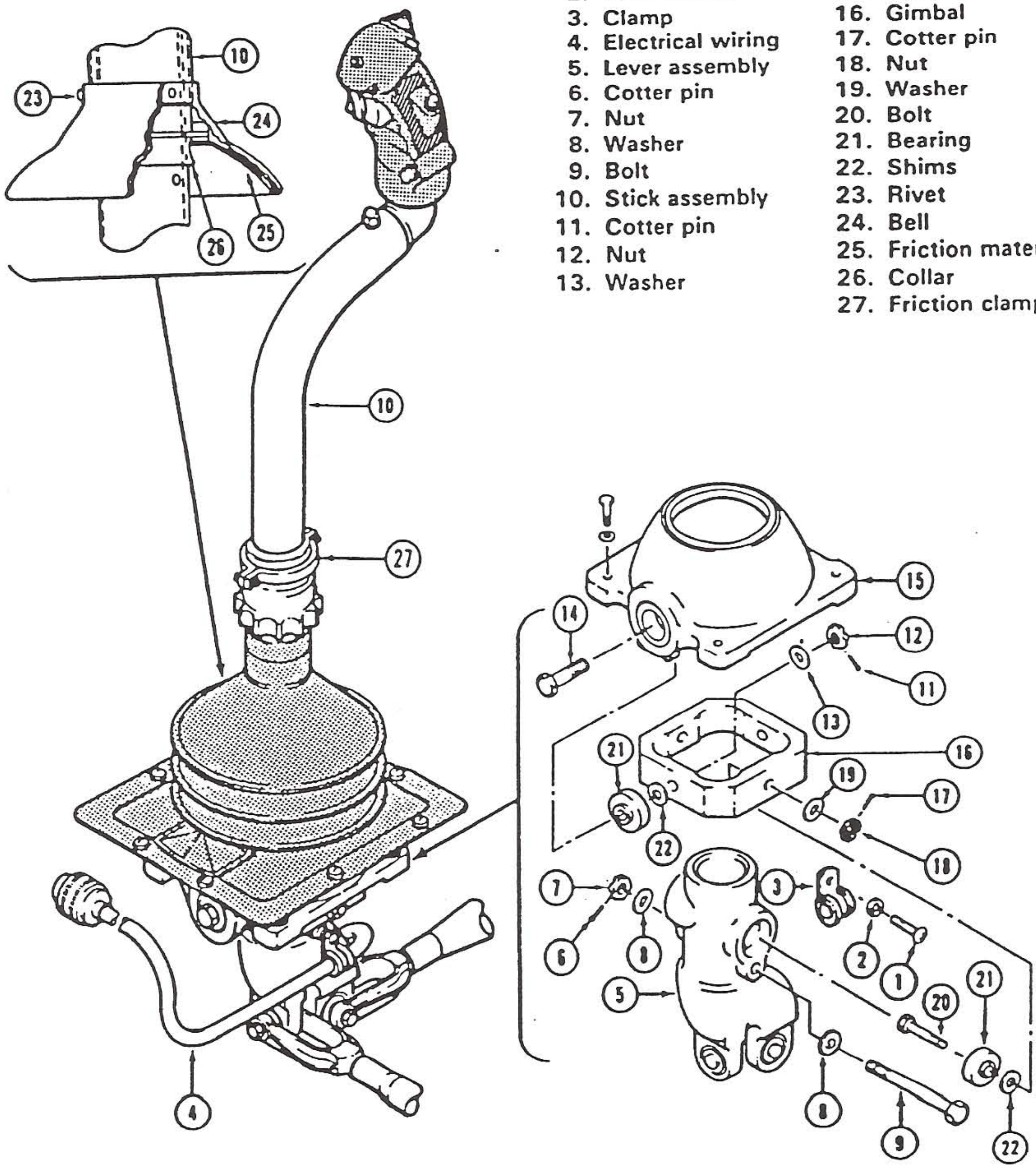
Two dual hydraulic servo actuators provide hydraulic boost to the controls and prevent rotor feedback forces from moving the controls.

When the dual controls kit is installed, the copilots control stick is connected by adjustable tubes to the fore-aft and lateral systems.

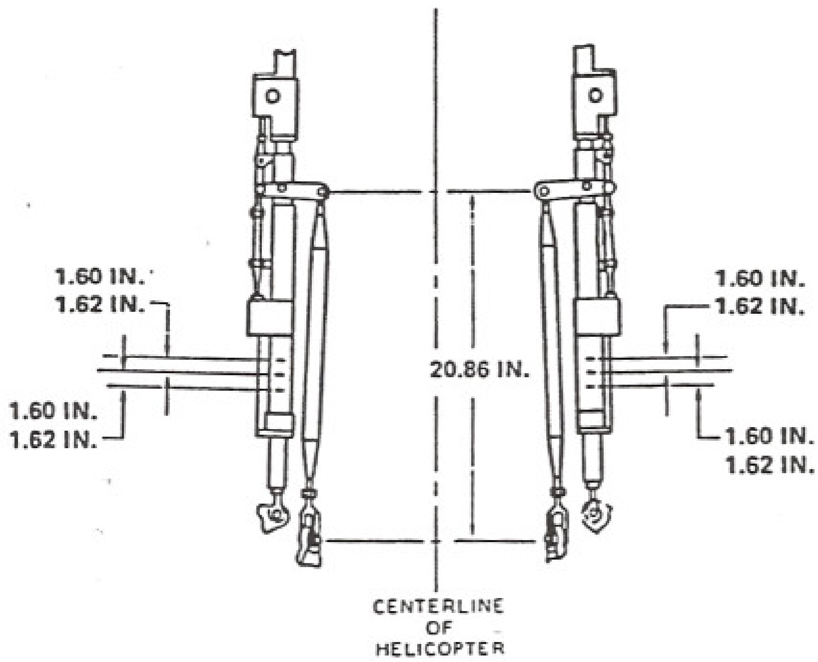
Bell

CYCLIC CONTROL STICK ASSEMBLY

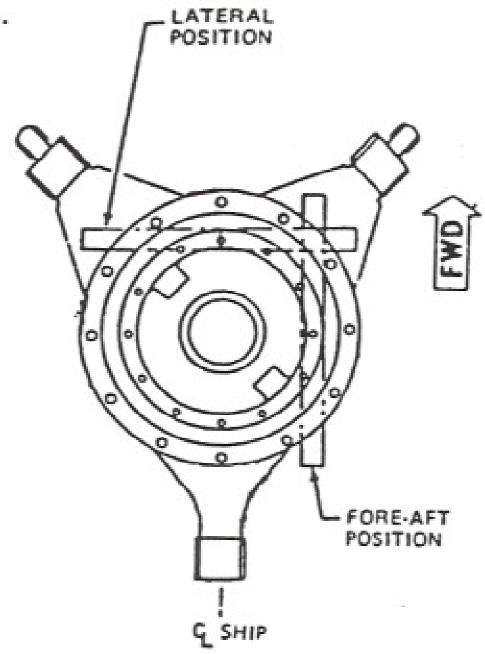
1. Screw
2. Lock washer
3. Clamp
4. Electrical wiring
5. Lever assembly
6. Cotter pin
7. Nut
8. Washer
9. Bolt
10. Stick assembly
11. Cotter pin
12. Nut
13. Washer
14. Bolt
15. Support assembly
16. Gimbal
17. Cotter pin
18. Nut
19. Washer
20. Bolt
21. Bearing
22. Shims
23. Rivet
24. Bell
25. Friction material
26. Collar
27. Friction clamp



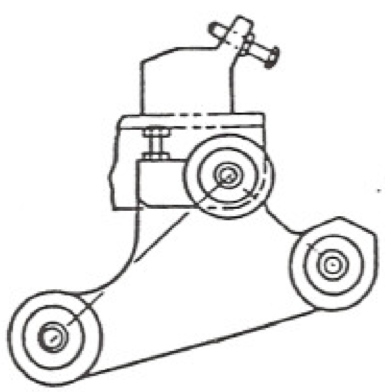
CYCLIC RIGGING



VIEW LOOKING AFT

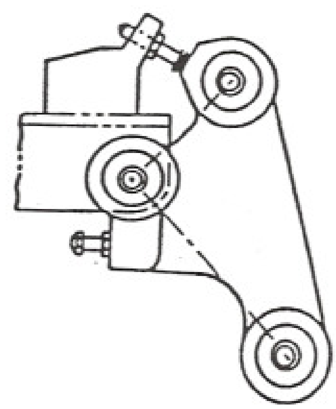


T103262 RIGGING TOOL
(PLATFORM FOR INCLINOMETER)



LEFT BELLCRANK
STICK FORWARD LEFT

RIGHT BELLCRANK
STICK FORWARD RIGHT



LEFT BELLCRANK
STICK AFT RIGHT

RIGHT BELLCRANK
STICK AFT LEFT

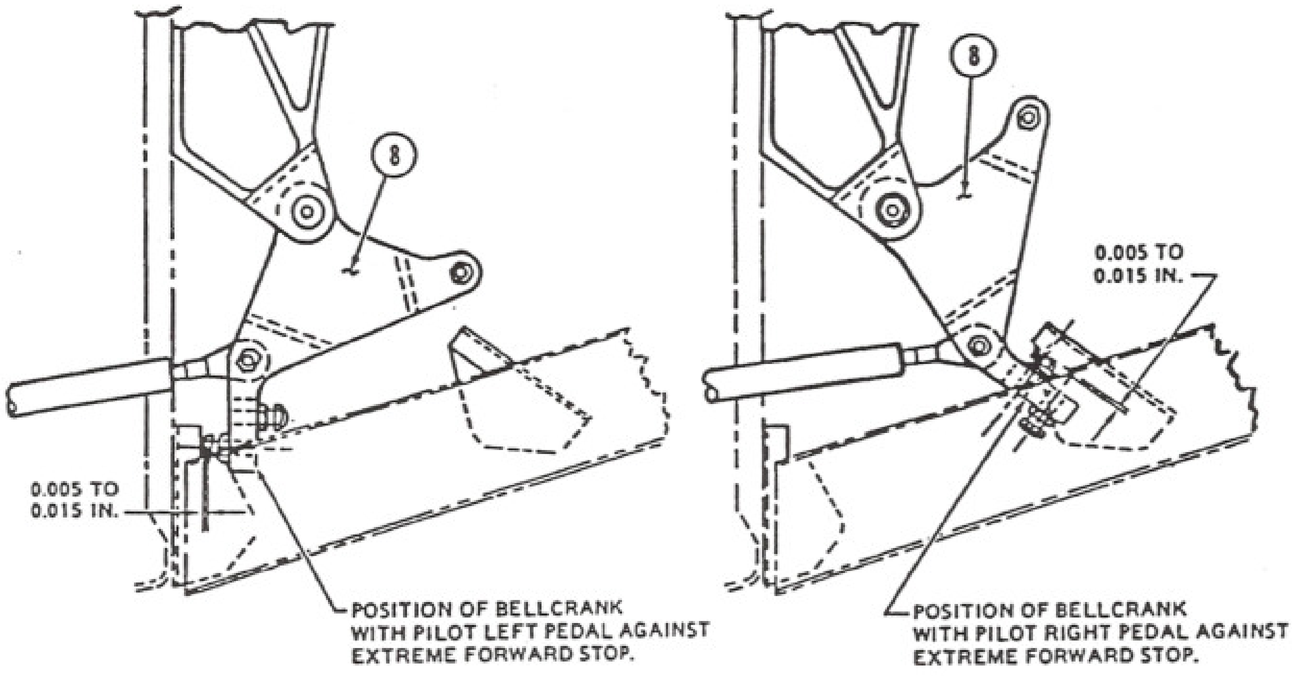
ANTI-TORQUE CONTROL SYSTEM

The anti-torque control system transmits control movement from the control pedals to the tail rotor located on the upper right side of the tail fin. Actuation of the system causes a hydraulic power assisted pitch change of the tail rotor blades to offset main rotor torque and to control the directional heading of the helicopter.

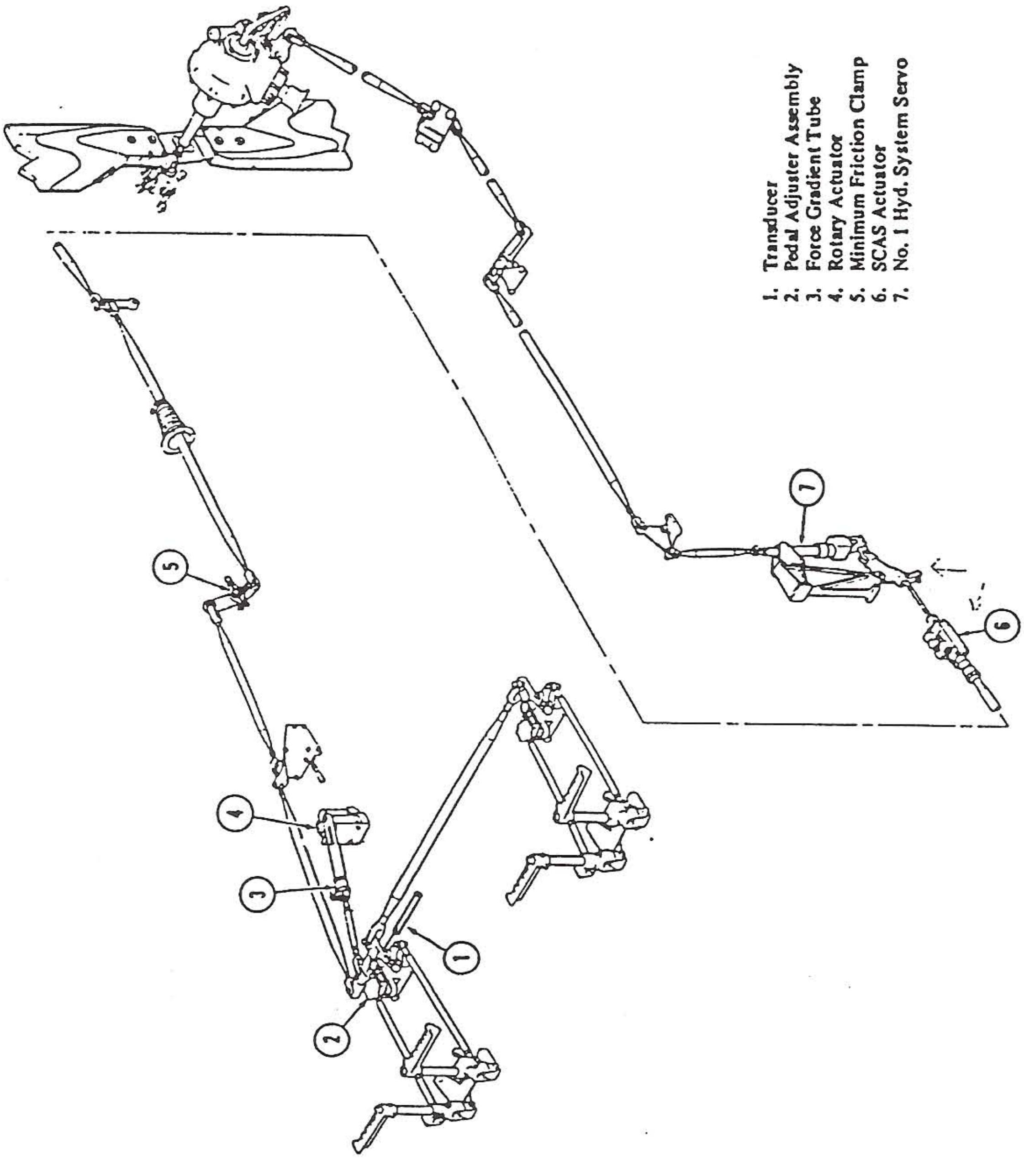
The system includes control pedals, pedal adjuster assembly, linear actuator, hydraulic servo actuator and connecting linkage to the pitch change mechanism at the tail rotor gearbox and tail rotor. A transducer and force gradient assembly with a magnetic brake connects to the pedal adjuster assembly which has a connecting point for the copilot's controls when the dual controls kit is installed.

Bell

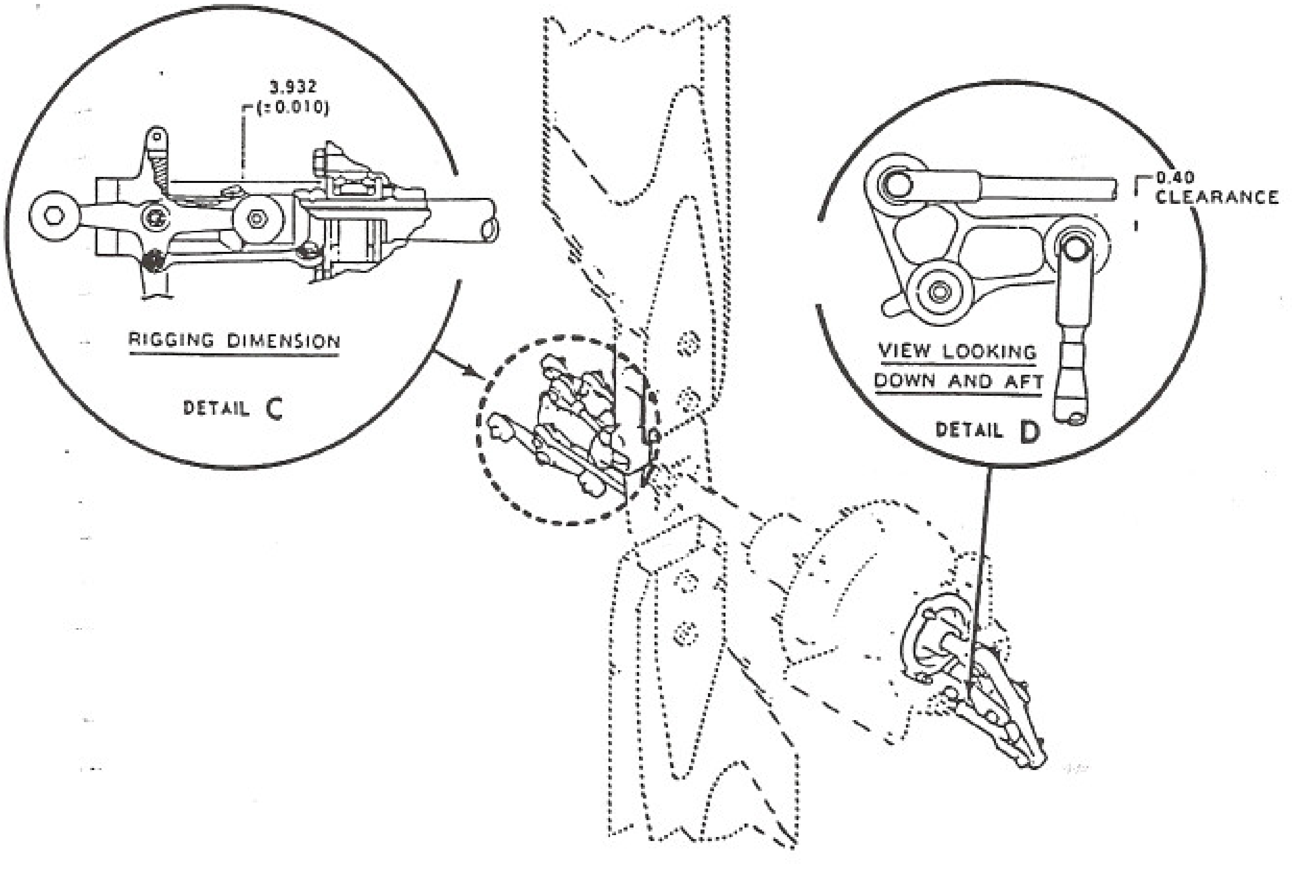
ANTI-TORQUE STOPS RIGGING



Bell



Tail Rotor Control System

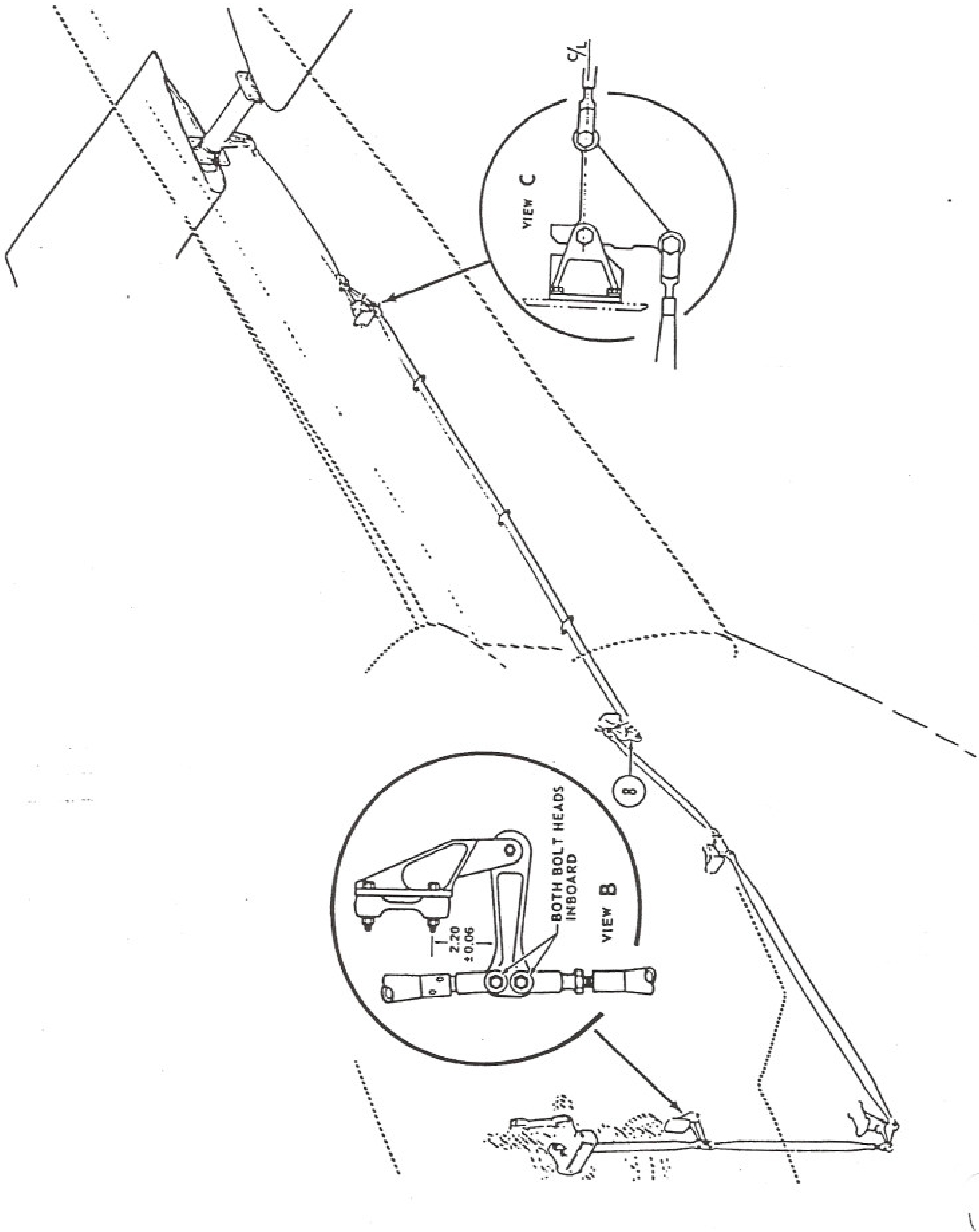


Anti-Torque Controls

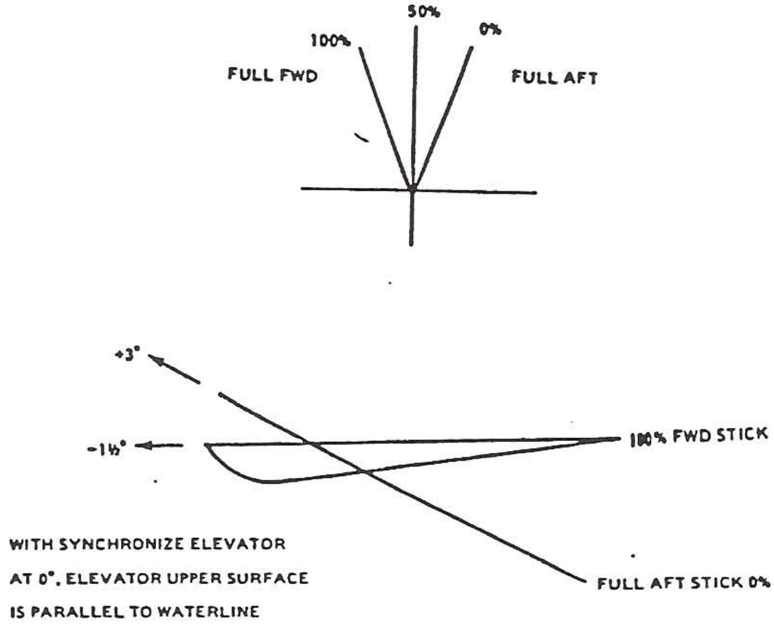
SYNCHRONIZED ELEVATOR CONTROLS

A synchronized elevator, which serves to increase controllability, is mounted on the tail boom and is connected to the cyclic control system at the aft side of the swashplate inner ring by linkage push-pull tubes and bellcranks.

Notes



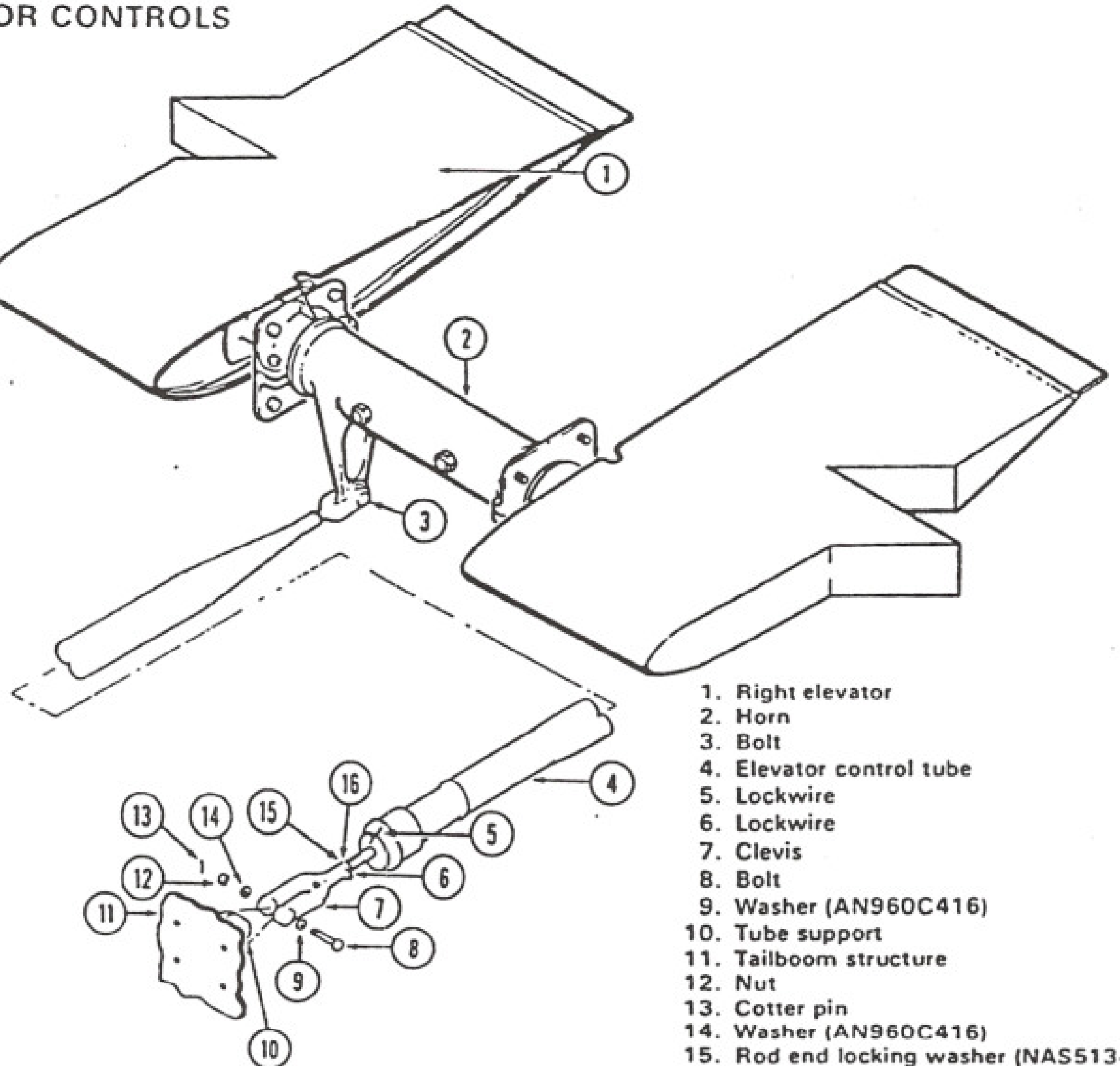
Synchronized Elevator Control Installation



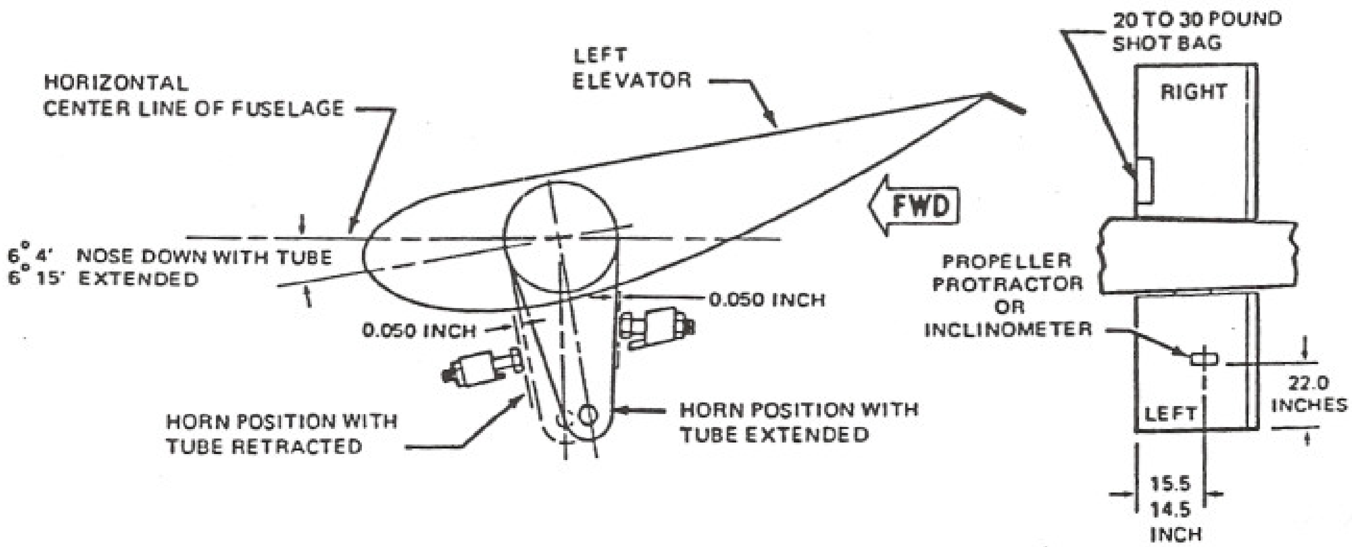
SYNCHRONIZED ELEVATOR

Notes

ELEVATOR CONTROLS



1. Right elevator
2. Horn
3. Bolt
4. Elevator control tube
5. Lockwire
6. Lockwire
7. Clevis
8. Bolt
9. Washer (AN960C416)
10. Tube support
11. Tailboom structure
12. Nut
13. Cotter pin
14. Washer (AN960C416)
15. Rod end locking washer (NAS513-7)
16. Nut

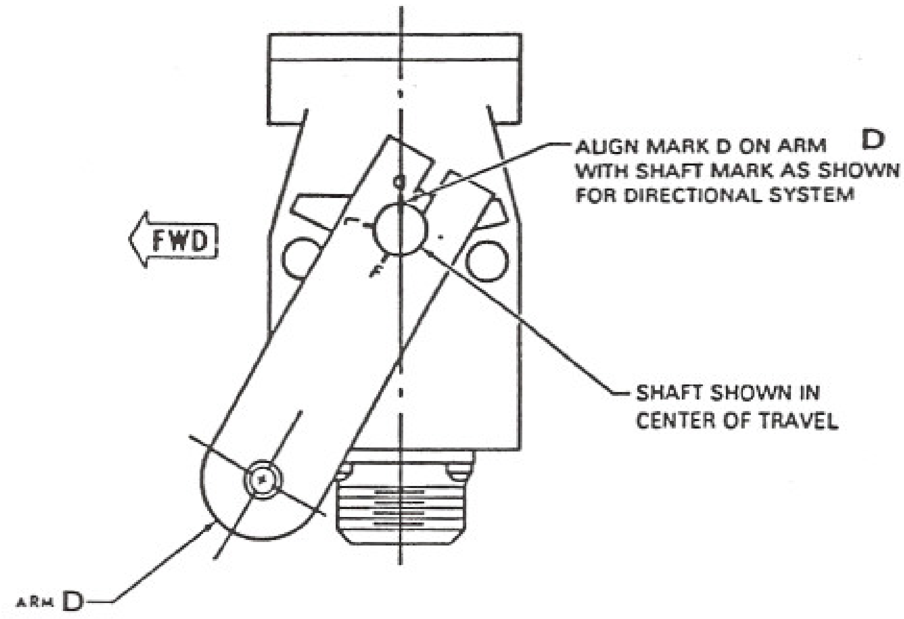


FORCE TRIM COMPONENTS (ANTI-TORQUE)

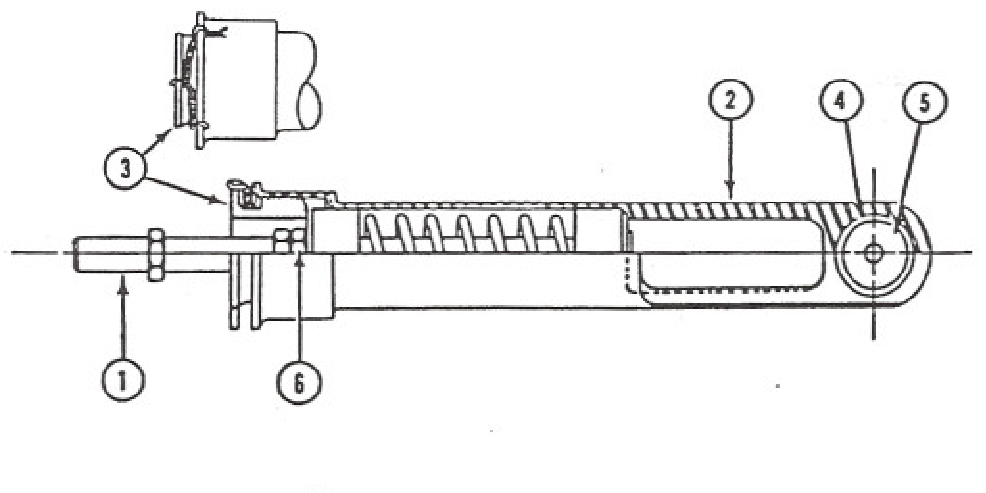
A force gradient assembly is used in the anti-torque control system in conjunction with a magnetic brake assembly. These assemblies serve to give an artificial "feel" to the control pedals and enable the pilot to trim the controls. The force gradient is functionally similar to the cyclic force gradients but does not have an electrical switch.

Bell

FORCE TRIM COMPONENTS (ANTI-TORQUE)



MAGNETIC BRAKE

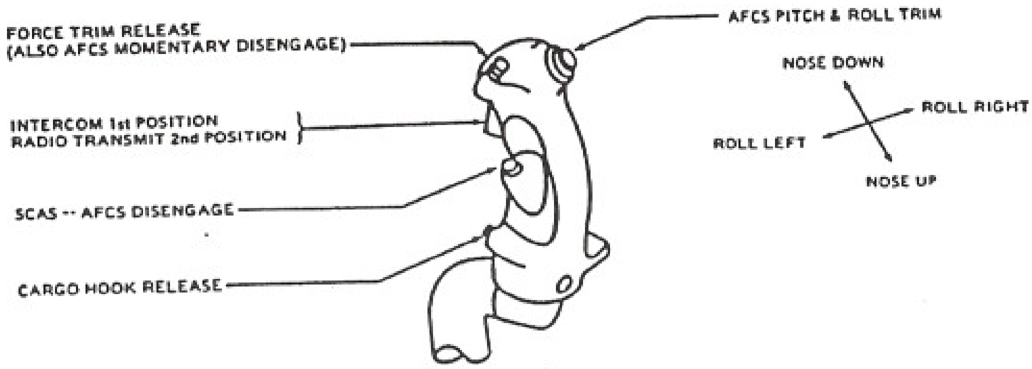


1. Spring assembly
2. Housing
3. Cap
4. Sleeve
5. Bearing
6. Nuts

FORCE GRADIENT

The AFCS control panel on the pedestal, contains roll and pitch trim wheels allowing the pilot to fine trim each axis without disengaging the other axis. The roll and pitch attitudes may also be individually trimmed by the "hat" switch on the cyclic grip. The control panel contains a yaw control allowing the pilot to fly the aircraft to a new heading without disengaging the other channels. The turn knob must be depressed and then rotated to the desired rate of turn. When the knob is depressed the yaw axis is automatically disengaged allowing the aircraft to fly to the new heading. When the turn knob is returned to the neutral position the AFCS will hold the new heading.

Notes



PILOT AND CO-PILOT CYCLIC CRIPS

Notes

AUTOMATIC FLIGHT CONTROL SYSTEM

GENERAL

The Automatic Flight Control System (AFC) installed in the BHC Model 212 IFR helicopter has two basic modes of operation: stability, control augmentation (SCAS) and attitude retention. The augmentation (SCAS) mode is effective about the roll, pitch and yaw axes and provides precise response characteristics to maneuvering commands while creating an airframe which is highly dampened to external disturbances. The attitude retention mode provides three-axis stabilization and provides a fly-through capability.

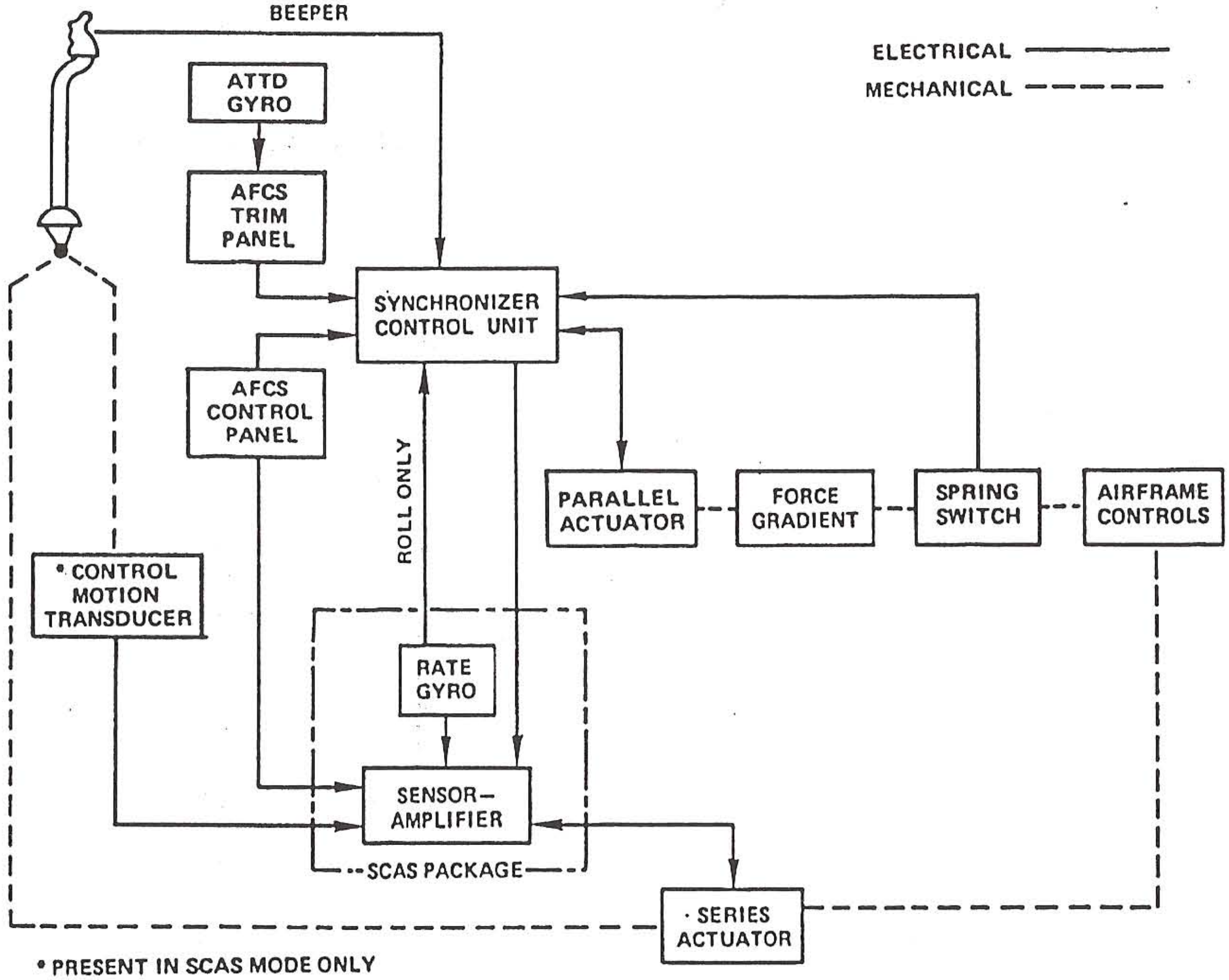
STABILITY AND CONTROL AUGMENTATION SYSTEM

In addition to providing a highly damped airframe, the system has high-quality control response characteristics for pilot inputs and includes a short term attitude memory function for external disturbances (e.g. wind gusts, etc). The SCAS inputs to the airframe are operationally applied in series with the pilot's controls and hence are not felt by the the pilot. A build-in safety feature automatically centers and mechanically locks each series actuator in case of electrical/hydraulic failure or upon disengagement of any channel(s).

The helicopter can be flown with the SCAS engaged without engaging the attitude retention system, the attitude retention system cannot be engaged without the SCAS engaged. The SCAS is armed, engaged and disengaged on the control panel located on the pedestal. The system can also be disengaged with a switch of the cyclic stick grip. With the SCAS only engaged, the helicopter can be flown in the conventional manner. The SCAS is composed of the following major components: a control panel, a sensor-amplifier unit, three control motion transducers and three electro-hydraulic servo actuators.

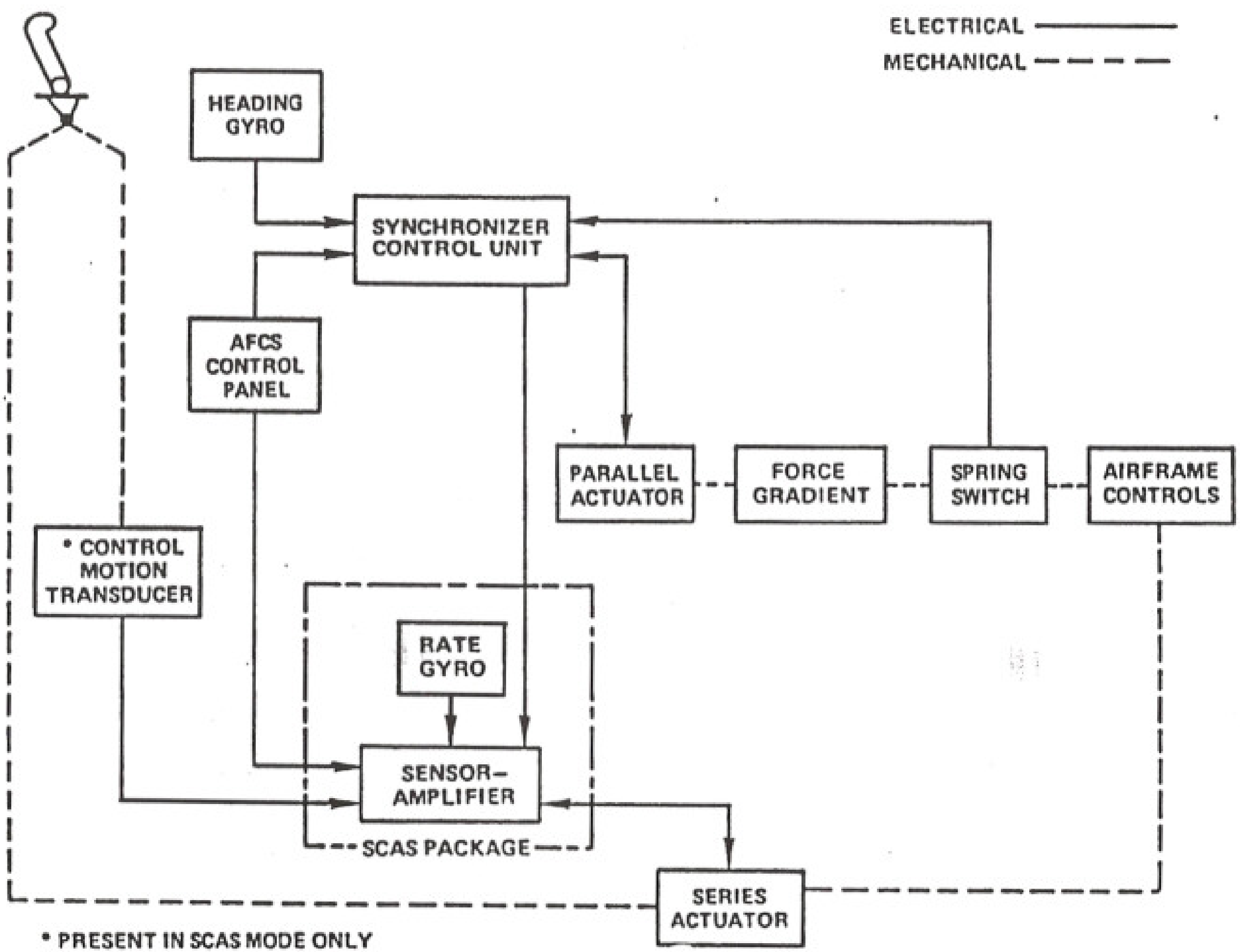
ATTITUDE RETENTION UNIT (ARU)

The Attitude Retention Unit (ARU) operates in conjunction with the pitch, roll and yaw channels of the SCAS to provide three-axis attitude stabilization. All three channels are interlocked with the SCAS control circuitry such that if any or all of the SCAS channel(s) are disengaged, the respective attitude channels are automatically disengaged. Therefore, the total attitude system can be disengaged with the SCAS cyclic stick disengage button switch.



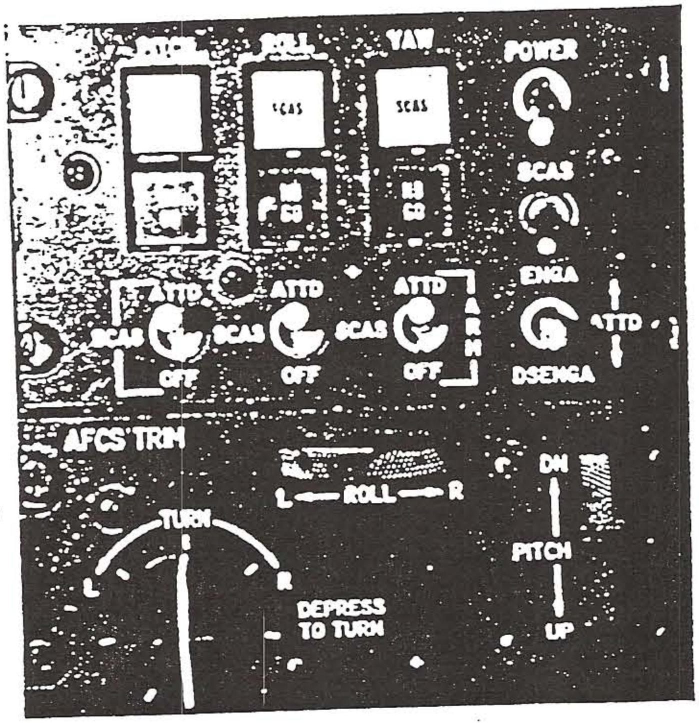
• PRESENT IN SCAS MODE ONLY

212 AFCS PITCH AND ROLL BLOCK DIAGRAM



* PRESENT IN SCAS MODE ONLY

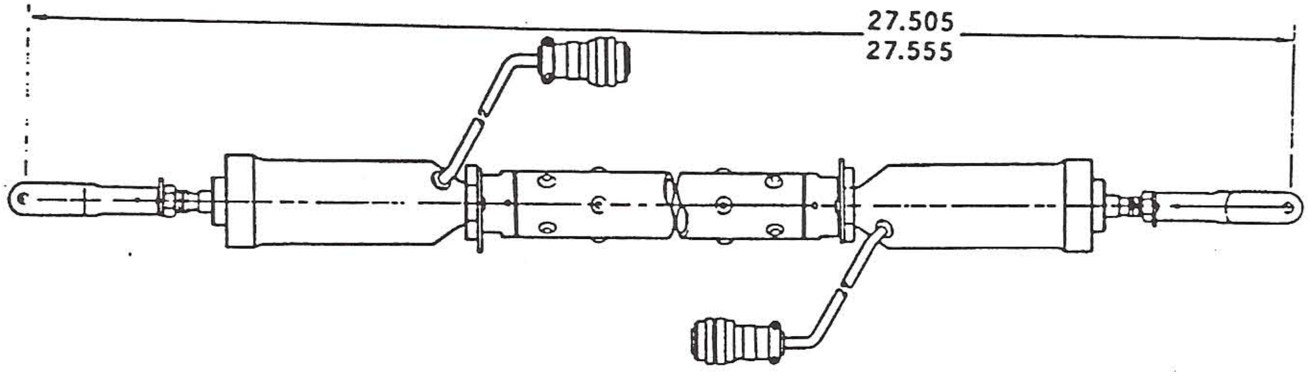
212 AFCS YAW' IAGRAM



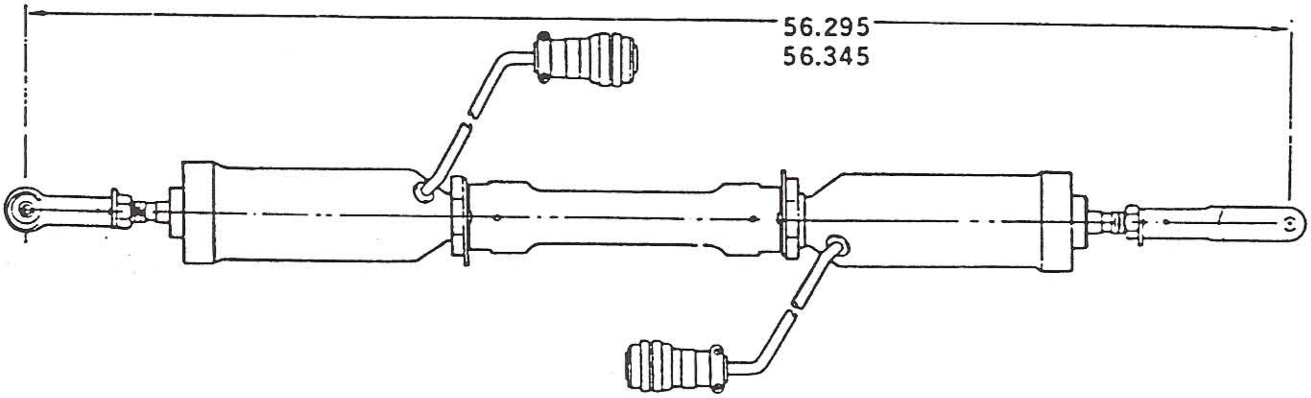
AFCS Control Panel

LINEAR ACTUATOR ASSEMBLIES

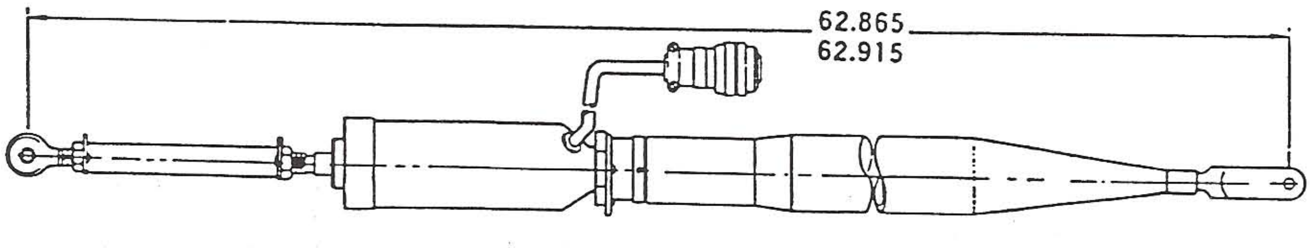
ALL DIMENSIONS MEASURED HOLE CENTER TO HOLE CENTER
WITH ACTUATOR CENTERED.



PITCH LINEAR ACTUATOR ASSEMBLY

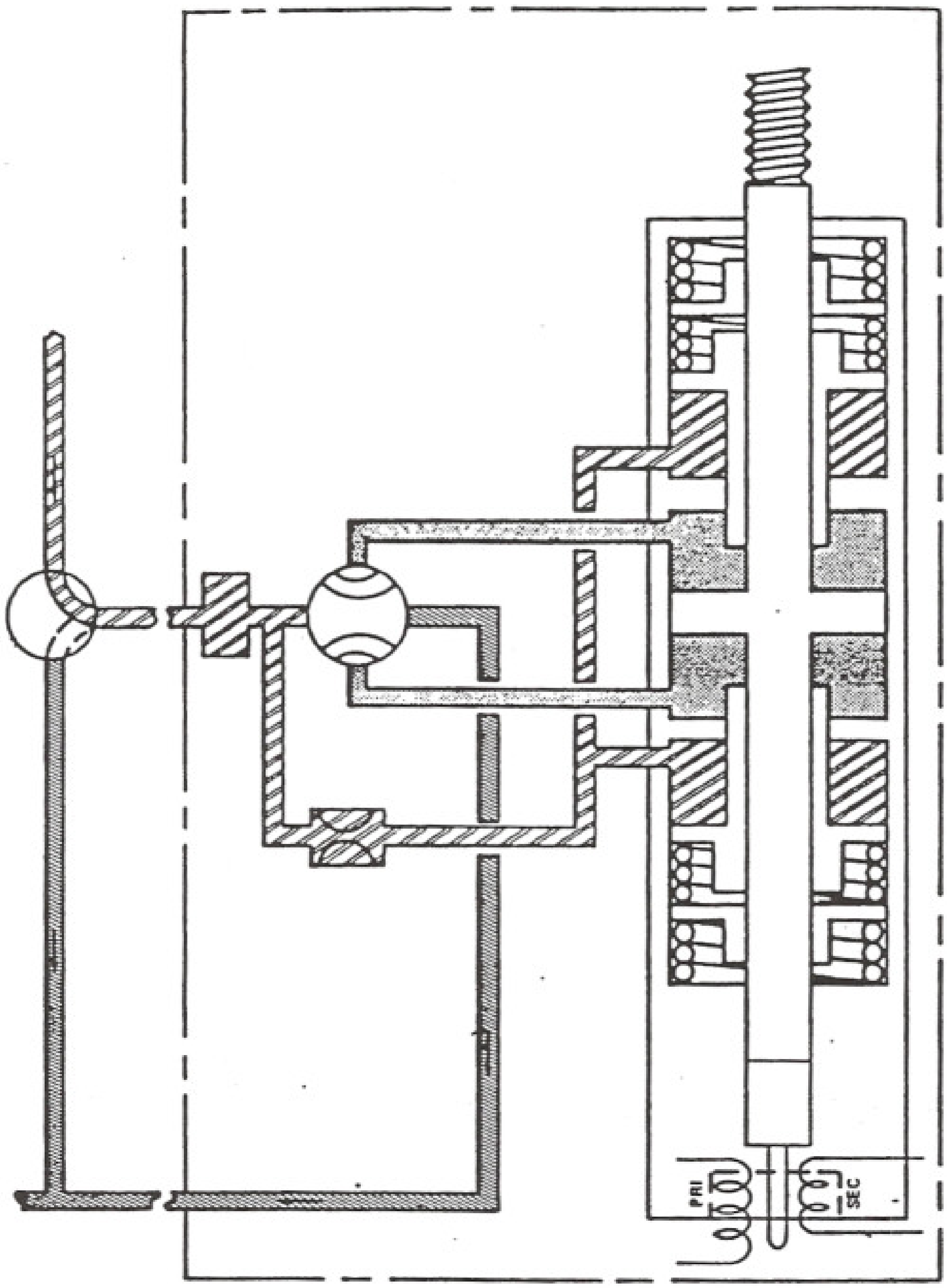


ROLL LINEAR ACTUATOR ASSEMBLY



YAW LINEAR ACTUATOR ASSEMBLY

ACTUATOR	TRAVEL	CONTROL AUTHORITY	
PITCH	± 0.138	±7%	14% TOTAL
ROLL	±0.157	±10.5%	21% TOTAL
YAW	±0.197	±6.5%	13% TOTAL



Series Actuator

PILOTS

BELL 212 SPERRY I.F.R.   AHX-BHF

A. AHX and BHF have dual start buss tie relays. These are installed to enable D.C. busses to be isolated in case of relay failure.

1) During the start mode the start control button is operated and energises two start relays (K10 and K101).

2) This links main bus 1 and 2 and also illuminates on the master caution "start buss release fail" light.

3) When the start button is released, the "light" will extinguish, indication that both start relays have de-energised.

B. The Flt/Interconnect override switch located on the overhead circuit breaker panel allows manual operation of the interconnect relay. (K37).

The starter generator relays are monitered by the addition of two extra relays. While the generators are on, these two monitoring relays are "energised."

In the event of a failure, (one generator fails), the respective monitoring relay will de-energise removing the ground from the interlock relay, thus dropping off the failed generator respective main bus. By placing the interconnect override switch from Flight to Overide position a ground is put back on the interconnect relay putting the failed main bus back on line.

C-FAHX
C-FBHF

GROUND OVERRIDE SWITCH

THE GROUND OVERRIDE SWITCH (OVERHEAD PANEL)

MUST BE IN THE FLY POSITION IN FLIGHT.

IF NO. 1 ENGINE OR ITS GENERATOR IS LOST OR OFF,

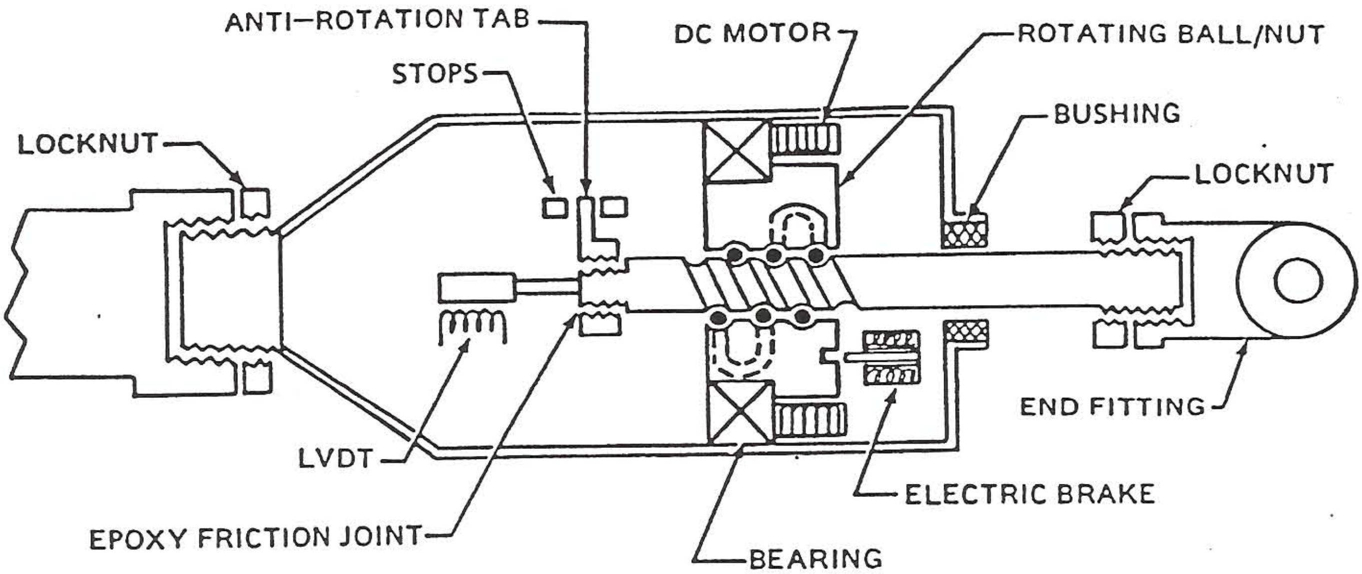
THERE IS NO BATTERY CHARGING BY NO. 2 GENERATOR.

TO RESTORE CHARGING, SWITCH OVERRIDE SWITCH TO

GROUND (AFT POSITION).

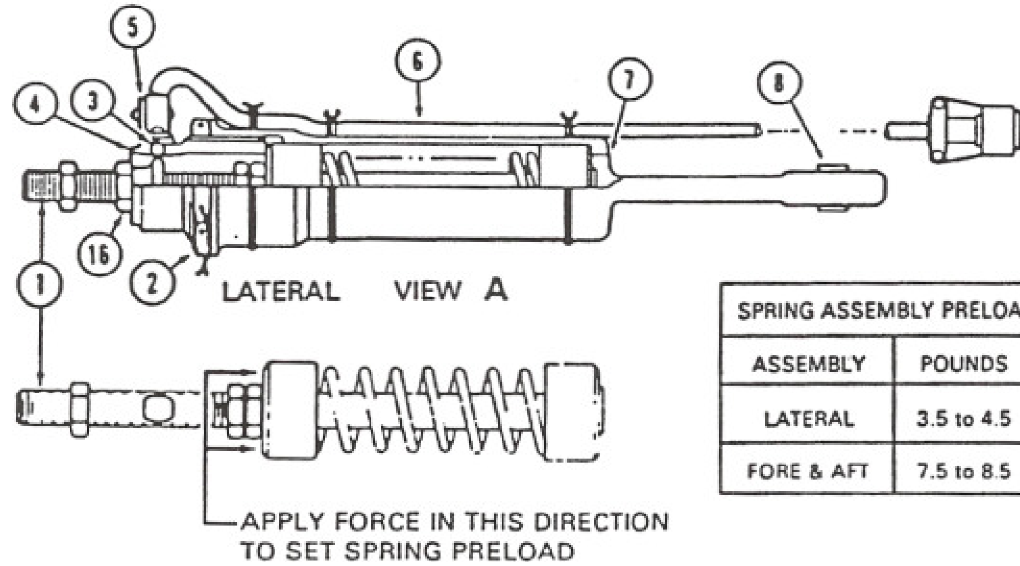
THE GROUND OVERRIDE SWITCH WHEN IN THE FLT. POSITION, INTERCONNECTS PRIMARY BUSS NO. 1 AND 2. IF GENERATORS 1 AND 2 ARE PRODUCING D.C. VOLTS.
IF NO.1 OR NO.2 GENERATOR IS LOST INTERCONNECT AUTOMATICALLY OPENS AND SEPARATES NO. 1 FROM NO. 2 PRIMARY BUSS.
IF THE SWITCH IS IN GROUND OVERRIDE (AFT POSITION), THE INTERCONNECT IS CLOSED AND THE PRIMARY BUSSES ARE CONNECTED.

SPERRY LINEAR ACTUATOR

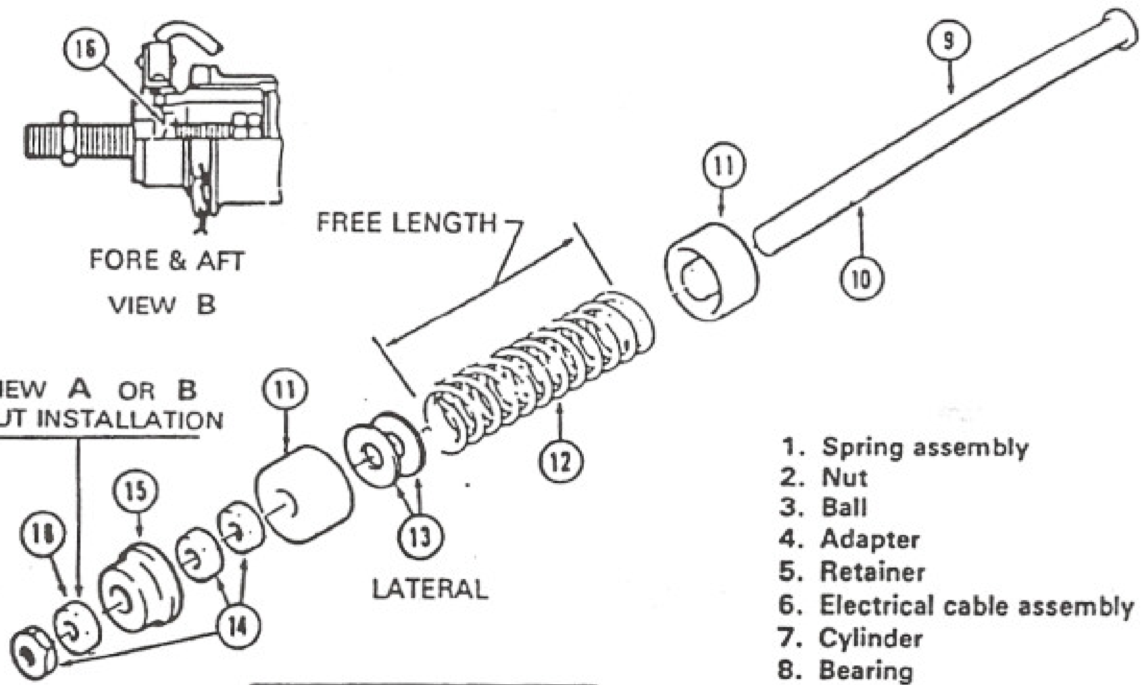


Bell

FORCE GRADIENTS — CYCLIC SYSTEM



SPRING ASSEMBLY PRELOAD	
ASSEMBLY	POUNDS
LATERAL	3.5 to 4.5
FORE & AFT	7.5 to 8.5

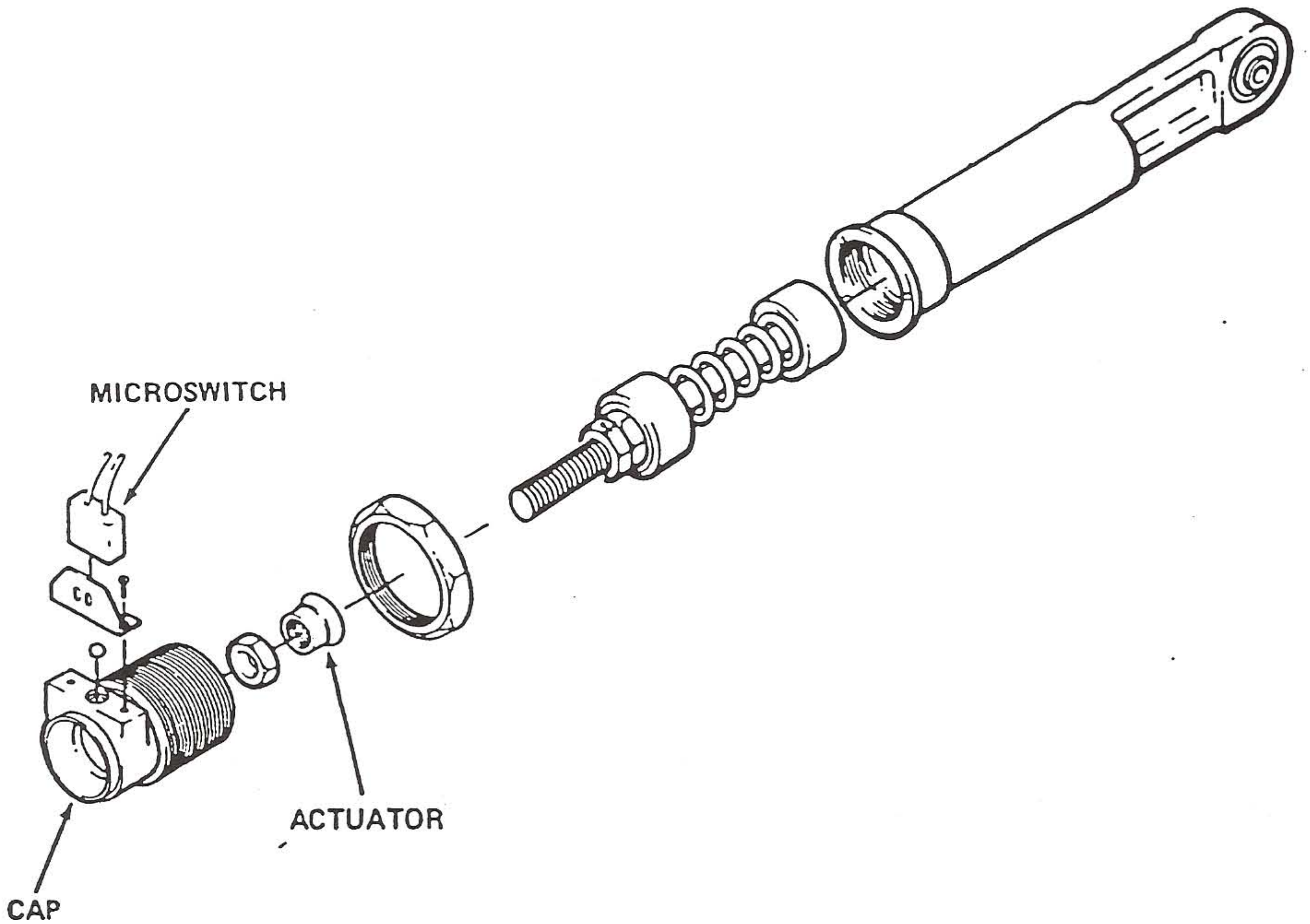


1. Spring assembly
2. Nut
3. Ball
4. Adapter
5. Retainer
6. Electrical cable assembly
7. Cylinder
8. Bearing
9. Shaft
10. Flat
11. Guide (2)
12. Spring
13. Washer (2)
14. Nut (3)
15. Actuator
16. Nut

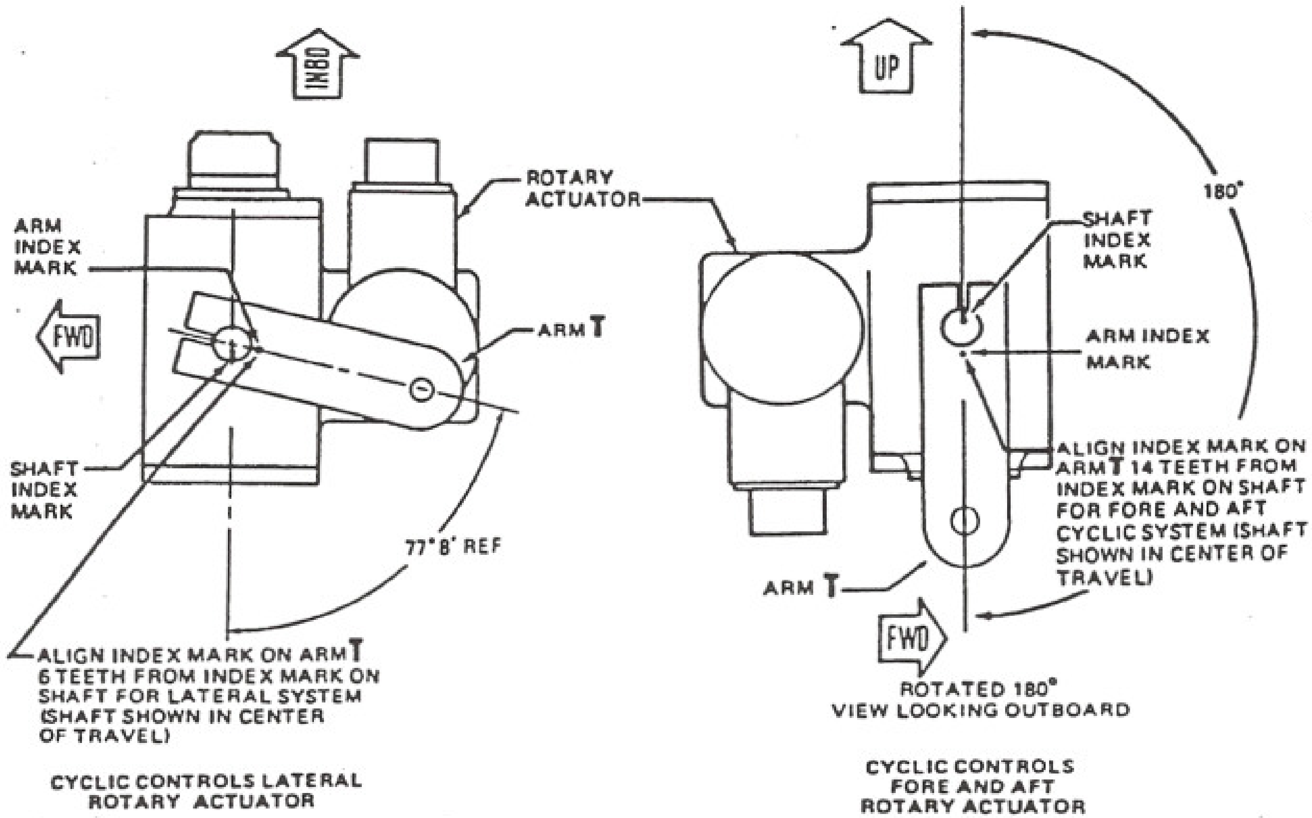
SPRING-FREE LENGTH	
ASSEMBLY	INCHES
LATERAL	4.49
FORE & AFT	4.96 4.84

FORCE GRADIENT ASSEMBLIES (CYCLIC)

Two force gradient assemblies are used in the cyclic control system in conjunction with rotary actuators. The assemblies serve to give artifical feel to the flight controls and will permit the pilot or co-pilot to override its respective rotary actuator. The force gradient assembly is a mechanical device, but incorporates an electric switch which is operated when the spring is compressed to allow the override feature. The two force gradients utilized in the cyclic controls are functionally similar, but not identical. Ensure that parts are not intermixed when both force gradient assemblies are disassembled at one time.



POSITIONING ARMS ON ROTARY ACTUATORS



ROTARY ACTUATORS

Two rotary actuators are used in the cyclic control system in conjunction with force gradients. The rotary actuators automatically keep the pitch and roll linear actuators near their center of travel (± 30%) to provide an automatic trim function when the Automatic Flight Control System (AFCS) is operating in the attitude mode (ATT) or coupled mode (CPL) with the flight director kit installed.

Bell

HYDRAULIC SYSTEMS

DESCRIPTION

Two similar but separate hydraulic systems are used to provide boost power to the flight controls. Both systems, System No. 1 and No. 2, operate the three dual hydraulic servo actuators in the main rotor control system, System No. 1 only supplies to the single actuator in the directional control system.

Although both systems supply boost power to the three dual hydraulic servo actuators in the main rotor control system, there is no connection between the two systems because each system uses separate passages and chambers inside the dual actuators. In the event that one system becomes disabled, the other system can still operate normally.

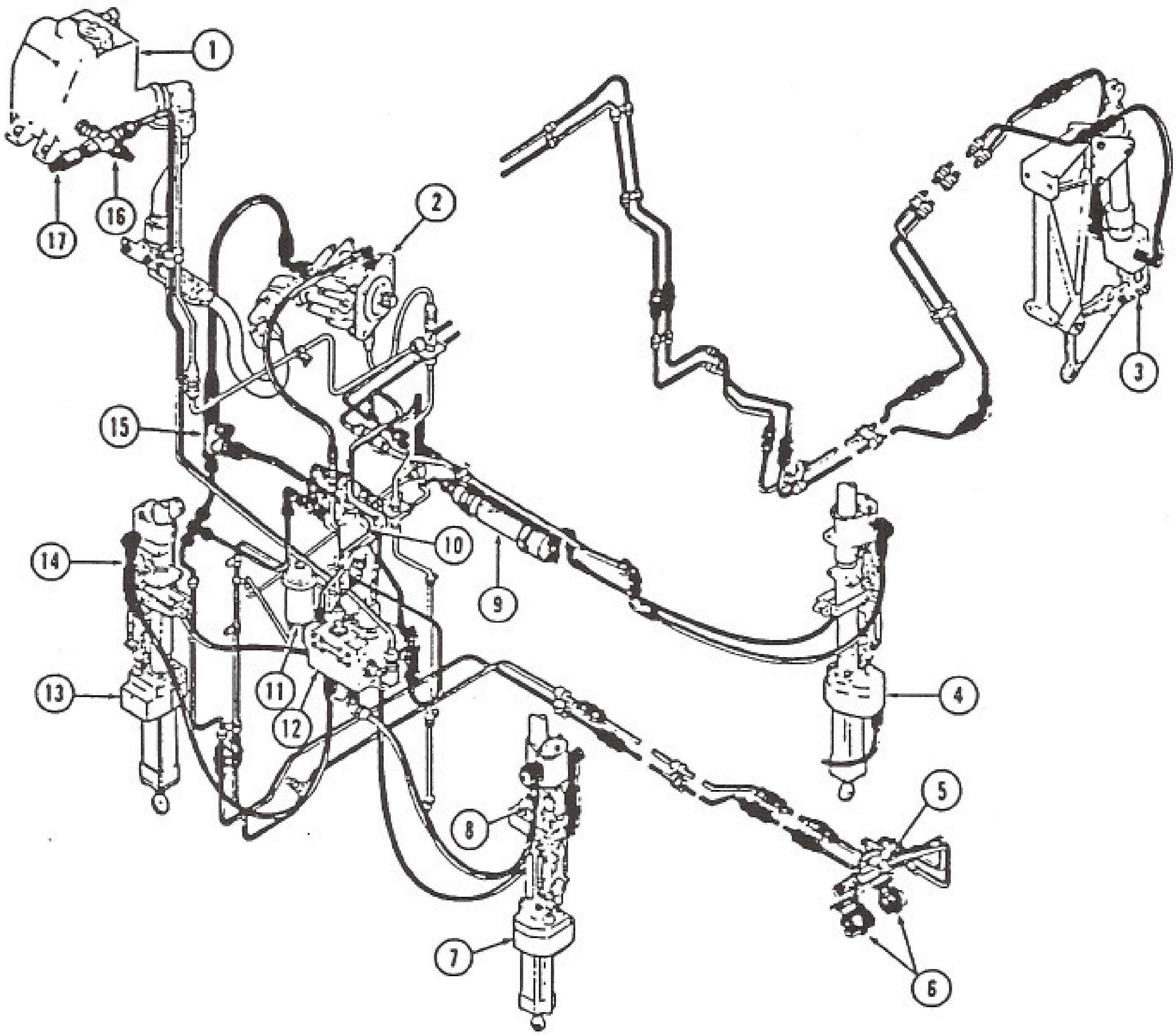
In normal operation of each system, hydraulic fluid is supplied from its non-pressurized reservoir, located beneath the transmission cowling, by gravity feed and suction to a transmission driven pump. The pump is a variable delivery type with internal pressure compensation, preset to provide 1000, plus or minus 25, psi output pressure. Pump line output is delivered to the intergrated valve and filter assembly, located in the pylon area below the transmission, and passes through the pressure filter. A relief valve in the intergrated valve and filter assembly protects the system against excessive pressure, being set to open a 1100 psi. The system solenoid valve is a "fail safe" valve, with the HYDR SYS switch in the cockpit positioned ON the valve is electrically de-energized and is electrically energized when the HYDR SYS switch is positioned oFF. In the event of an electrical failure while the HYDR SYS switch is positioned OFF, the valve would automatically return to the hydraulics ON position. From the solenoid valve the fluid is directed through a check valve to the hydraulic serve actuators of the flight controls, the three series actuators of the automatic flight control system and a pressure operated shut-off valve in the intergrated valve and filter assembly. The valve is opened under increasing fluid pressure, opening the return from the actuators, permitting normal hydraulic system operation. Upon decreasing pressure the valve is closed, blocking the return from the actuators thereby trapping fluid in the actuators, this action along with other functions prevents rotor feedback forces to be felt in the flight controls with the hydraulic system off. The three dual hydraulic servo actuators, right hand and left hand cyclic and collective, are hydraulic powered by hydraulic system 1 and system 2 providing complete redundant hydraulic boost power to the cyclic and collective flight controls. System 1 only supplies boost power to the directional control system.

Hydraulic pressure and temperature, for each system, is displayed on the instrument panel by a dual indicator from a temperature bulb at the reservoir inlet and a pressure transmitter at the intergrated valve and filter assembly outlet. Temperature switches, located on both System No. 1 and No. 2 reservoir inlets, and pressure switches, located in the pressure transmitter line, will illuminate the same segement, HYDRAULIC, on the Master Caution panel. With a failure of Hydraulic System No. 1 boost power to the directional control single hydraulic servo actuator will be lost, increased pedal forces would be noted with all other flight controls remaining powered. With a failure of Hydraulic System No. 2 all flight controls would remain powered.

Notes

HYDRAULIC SYSTEM 1

See TB 412-91-97 for replacement of system one hyd. tube P/N 212-076-348-001.

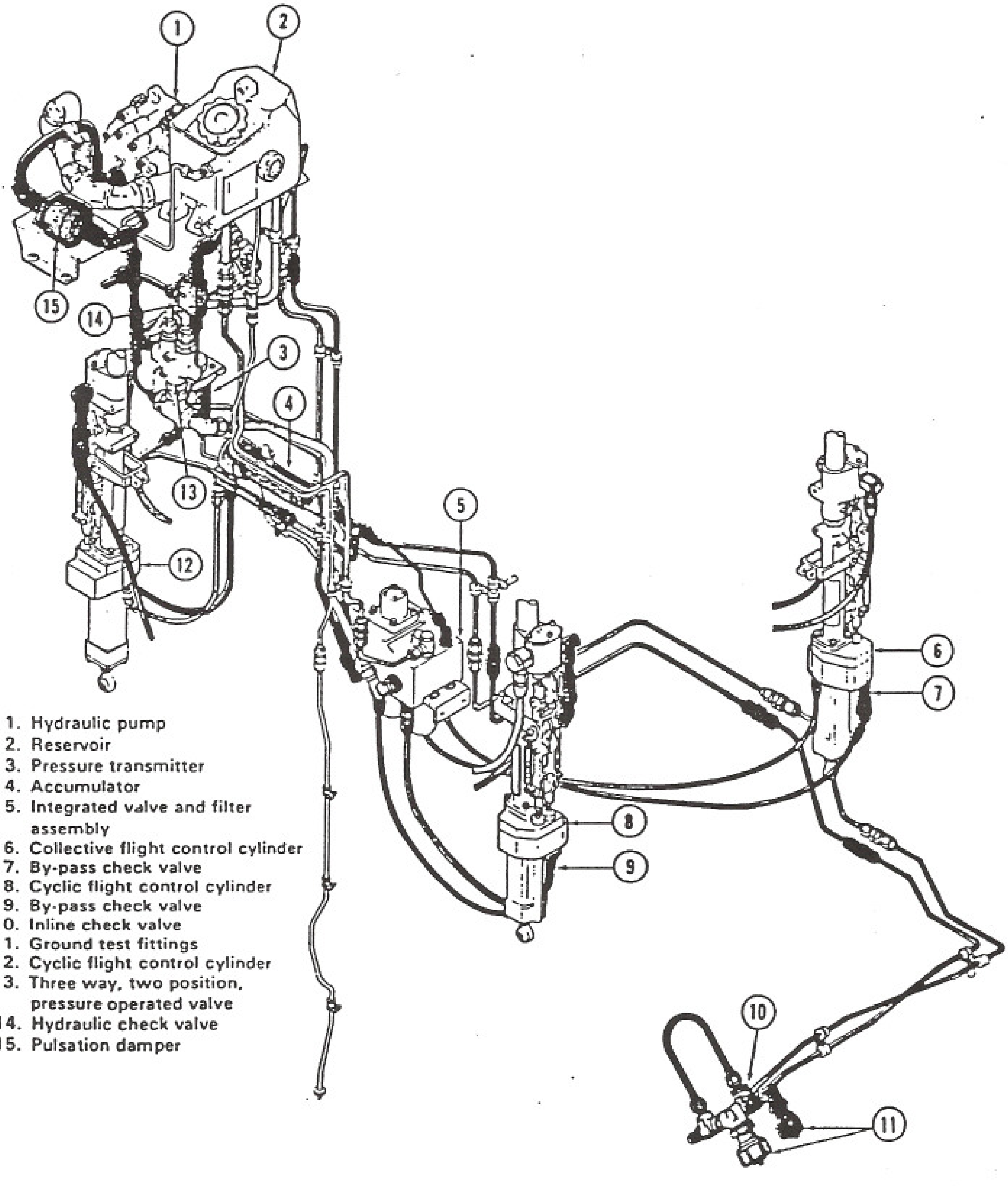


1. Reservoir
2. Hydraulic pump
3. Directional flight control cylinder
4. Collective flight control cylinder
5. Inline check valve
6. Ground test fittings
7. Cyclic flight control cylinders
8. By-pass check valve
9. Accumulator
10. Three way, two position, pressure operated valve
11. Pressure transmitter
12. Integrated valve and filter assembly
13. Cyclic flight control cylinder
14. By-pass check valve
15. Hydraulic check valve
16. Temperature bulb
17. Temperature switch

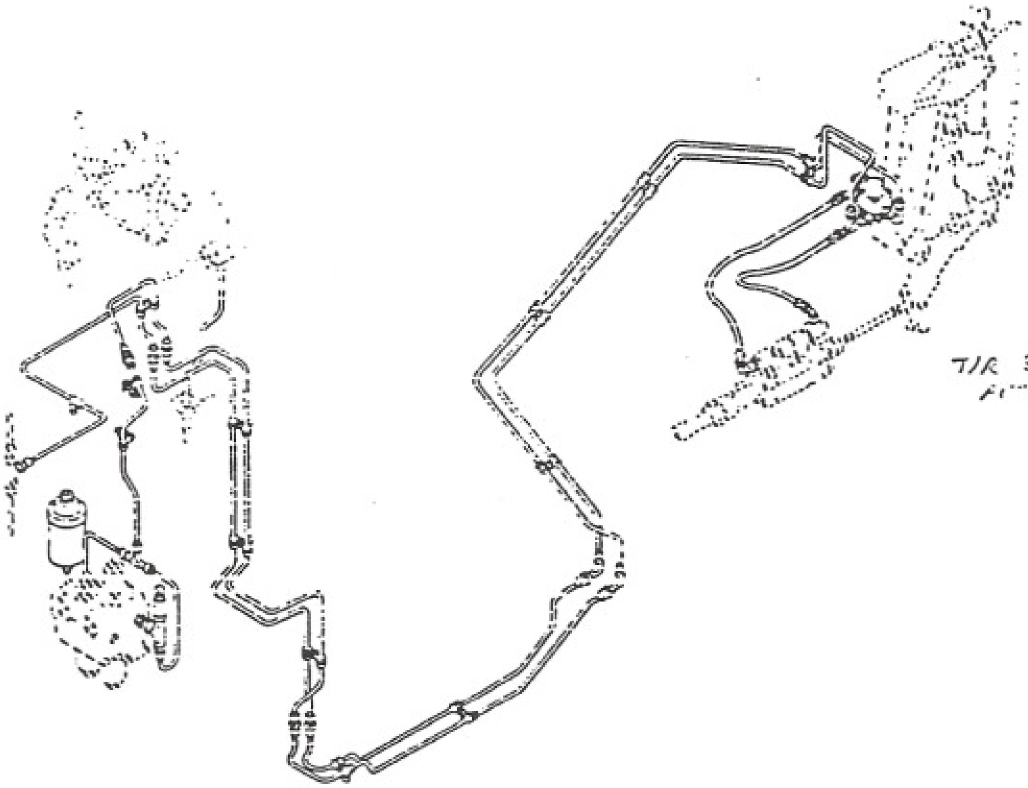
See TB 412-88-70 for replacement of aluminum alloy flareless tube fittings.

412076-2

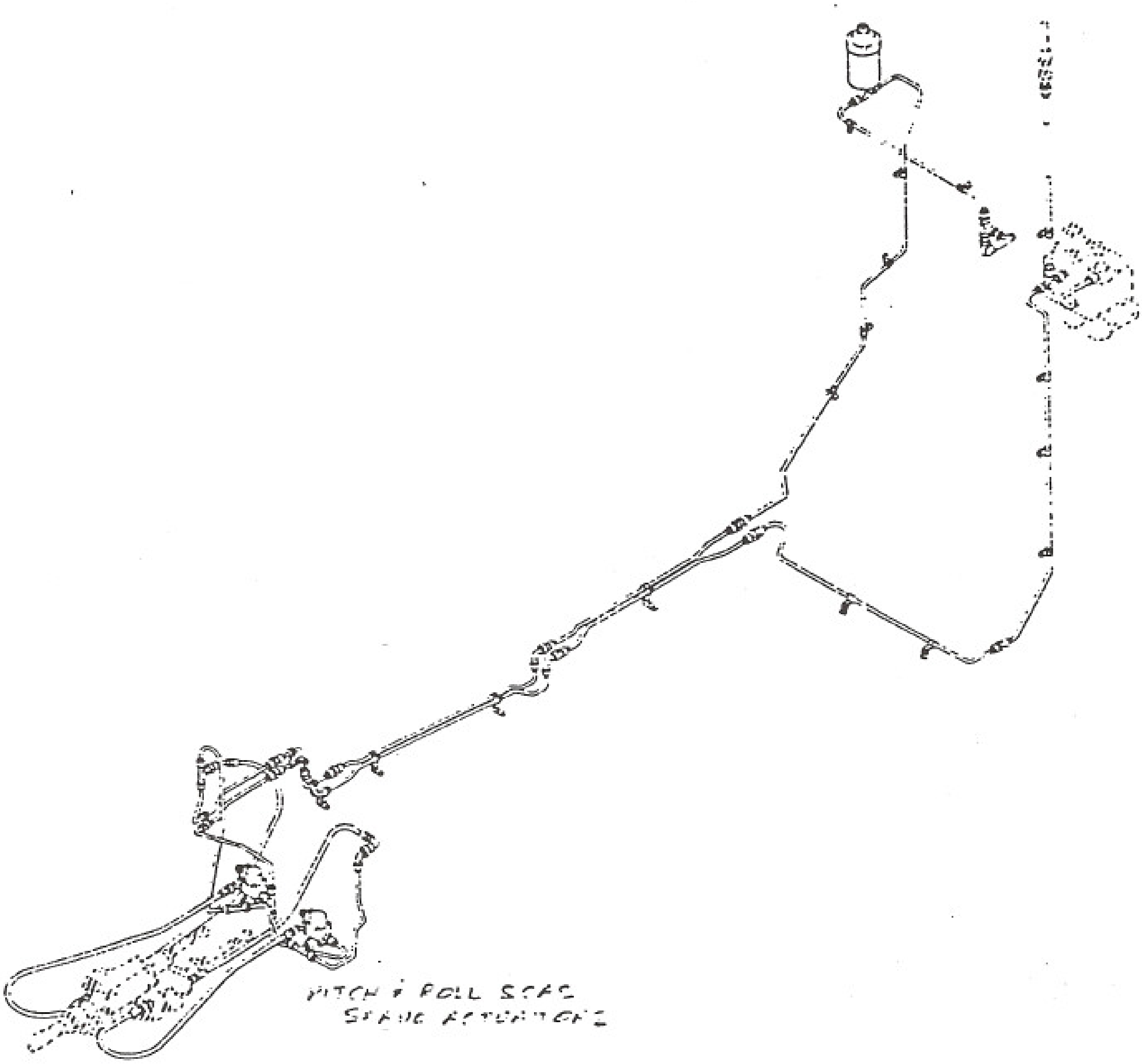
HYDRAULIC SYSTEM 2



1. Hydraulic pump
2. Reservoir
3. Pressure transmitter
4. Accumulator
5. Integrated valve and filter assembly
6. Collective flight control cylinder
7. By-pass check valve
8. Cyclic flight control cylinder
9. By-pass check valve
10. Inline check valve
11. Ground test fittings
12. Cyclic flight control cylinder
13. Three way, two position, pressure operated valve
14. Hydraulic check valve
15. Pulsation damper

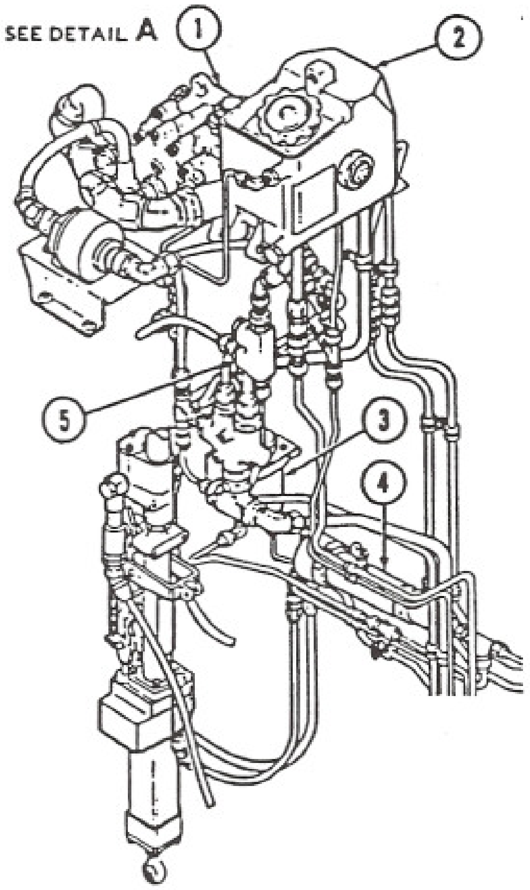


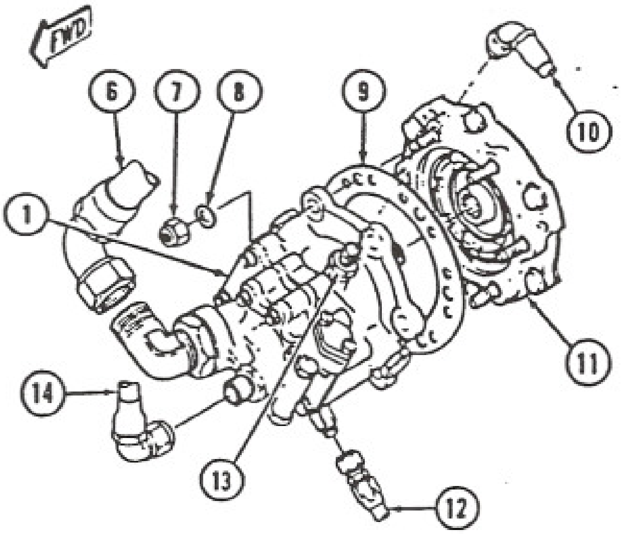
Hydraulic System 1 — I.F.R. Modification



Hydraulic System 2 — I.F.R. Modification

HYDRAULIC PUMP INSTALLATION (SYSTEM 2)





DETAIL A

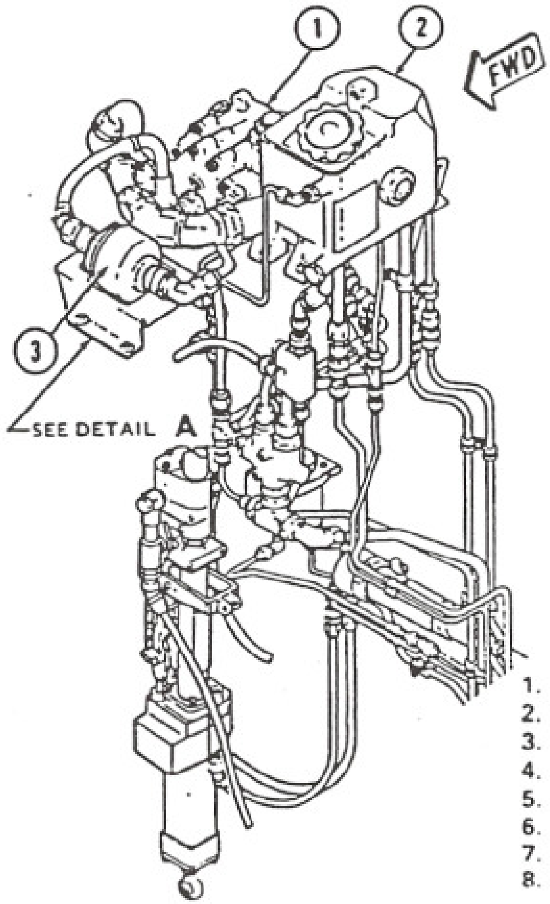
1. Hydraulic pump
2. Reservoir
3. Pressure transmitter
4. Accumulator
5. Hydraulic check valve
6. Pump suction hose
7. Nut
8. Aluminum washer
9. Gasket
10. Hose
11. Transmission
12. Hose
13. Inline check valve
14. Pump pressure hose

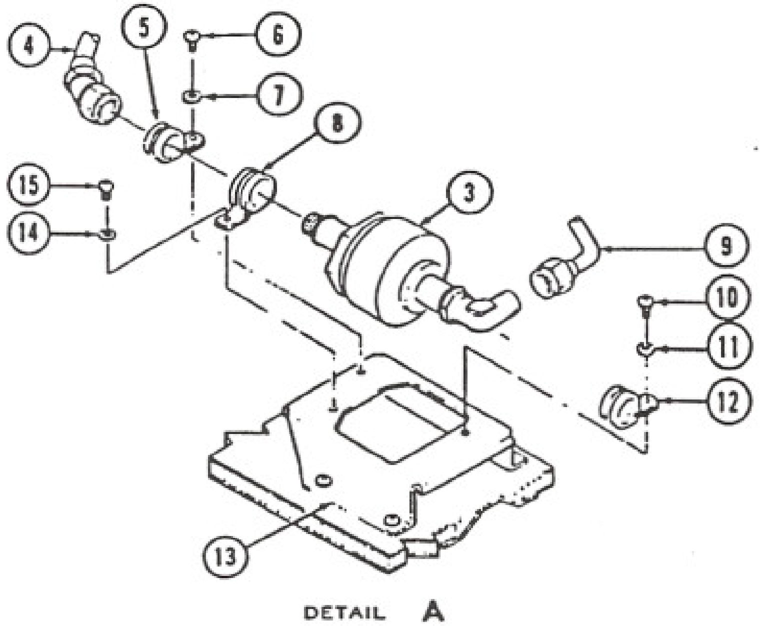
412076-7

Bell

SEE TB 412-91-100 FOR REPLACEMENT OF HYD. PUMP DRIVESHAFT.

PULSATION DAMPER INSTALLATION

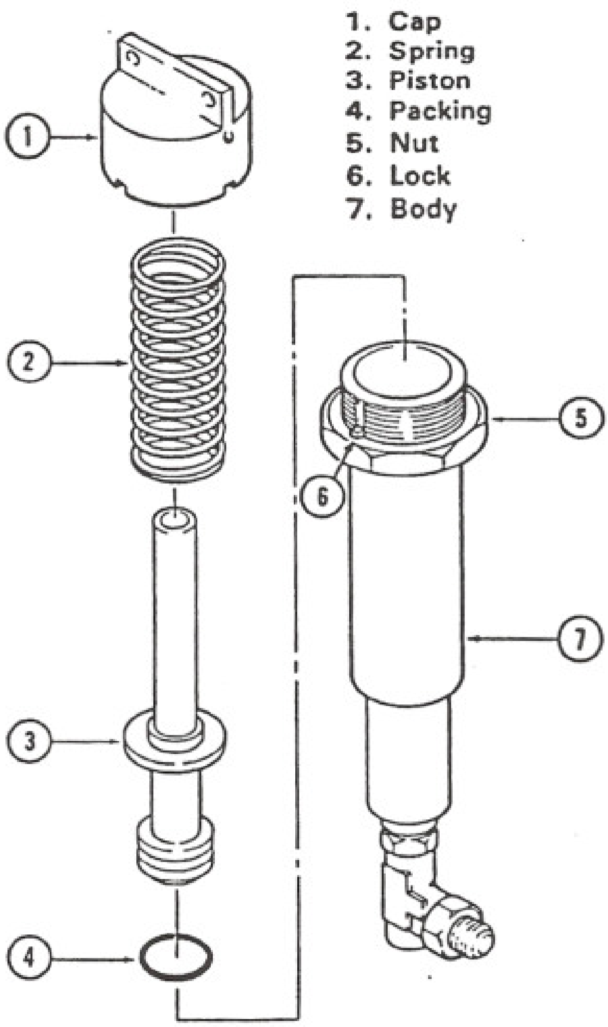


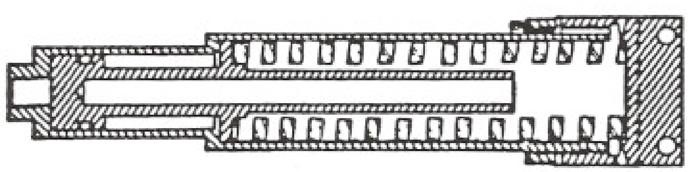


1. Hydraulic reservoir
2. Reservoir
3. Pulsation damper
4. Pump pressure hose
5. Clamp
6. Screw
7. Thin aluminum washer
8. Clamp
9. Tube
10. Screw
11. Thin aluminum washer
12. Clamp
13. Bracket
14. Thin aluminum washer
15. Screw

412076-9

HYDRAULIC ACCUMULATOR DISASSEMBLED

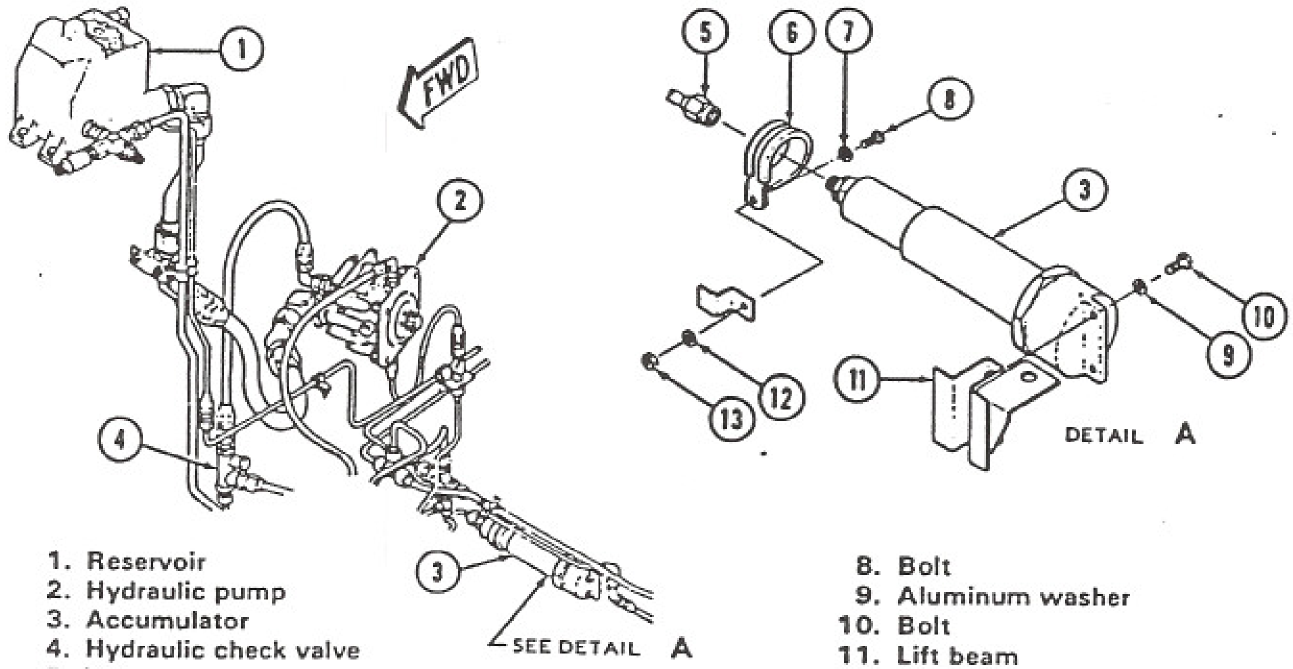




CROSS SECTION OF ASSEMBLY

212076-6

ACCUMULATOR INSTALLATION (SYSTEM 1 TYPICAL)

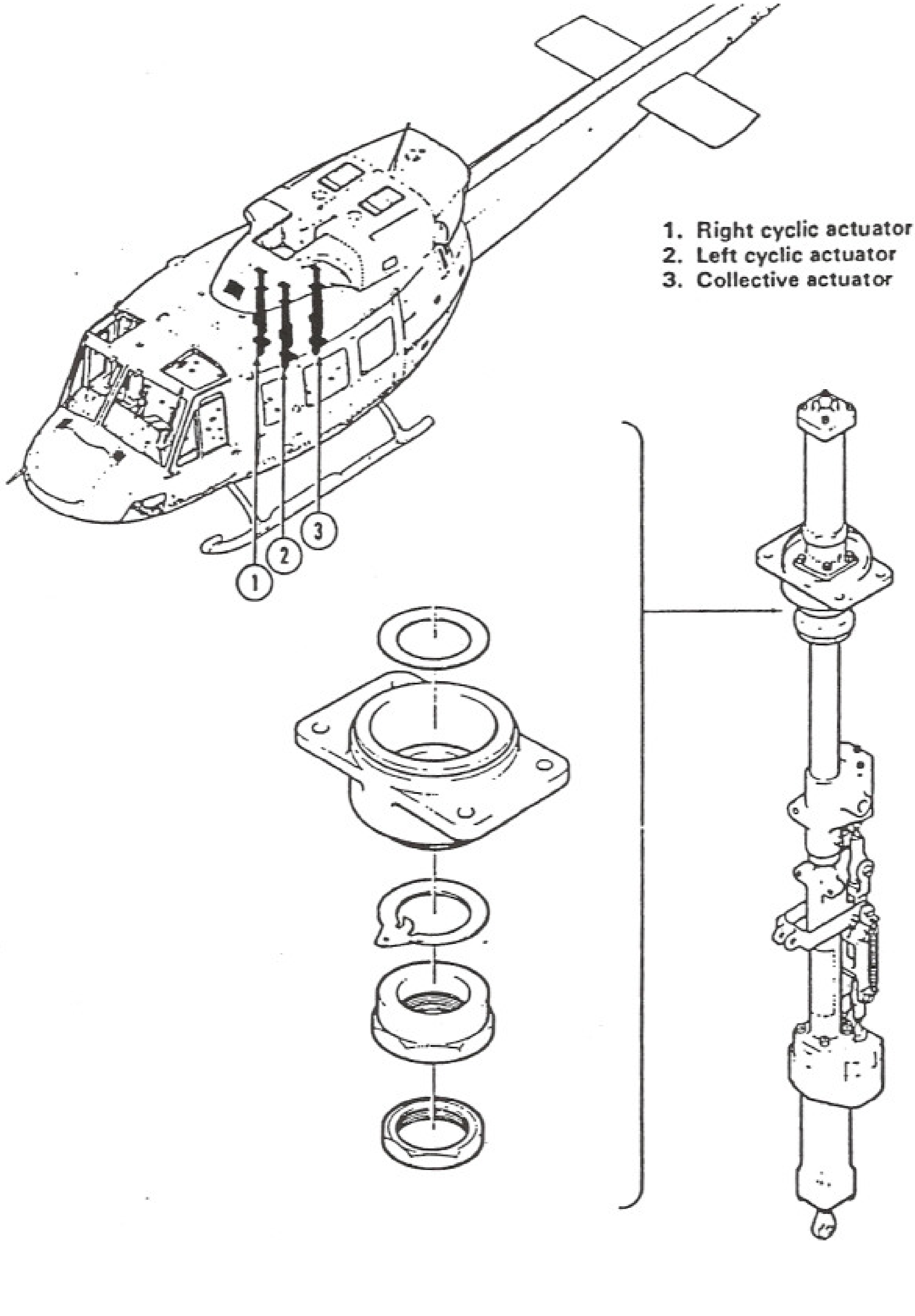


1. Reservoir
2. Hydraulic pump
3. Accumulator
4. Hydraulic check valve
5. Tube
6. Clamp
7. Aluminum washer
8. Bolt
9. Aluminum washer
10. Bolt
11. Lift beam
12. Aluminum washer
13. Nut

412076-8

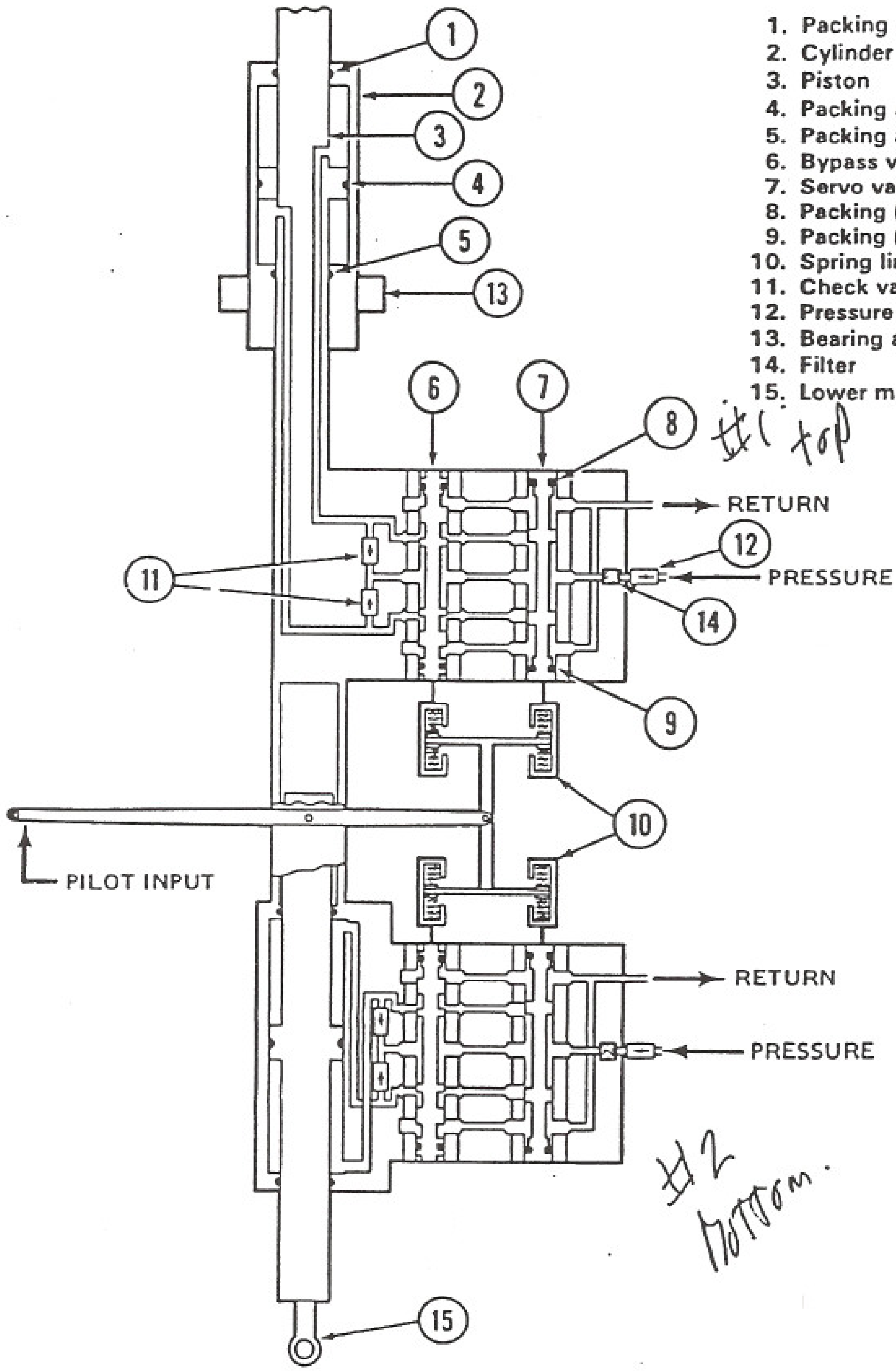
Bell

DUAL SERVO ACTUATOR ASSEMBLY



1000 PSI

DUAL SERVO ACTUATOR SCHEMATIC



1. Packing and channel seal
2. Cylinder
3. Piston
4. Packing and channel seal
5. Packing and channel seal
6. Bypass valve
7. Servo valve
8. Packing (Jo seal)
9. Packing (Jo seal)
10. Spring link assembly
11. Check valve
12. Pressure operated check valve
13. Bearing and cylinder support
14. Filter
15. Lower mounting point

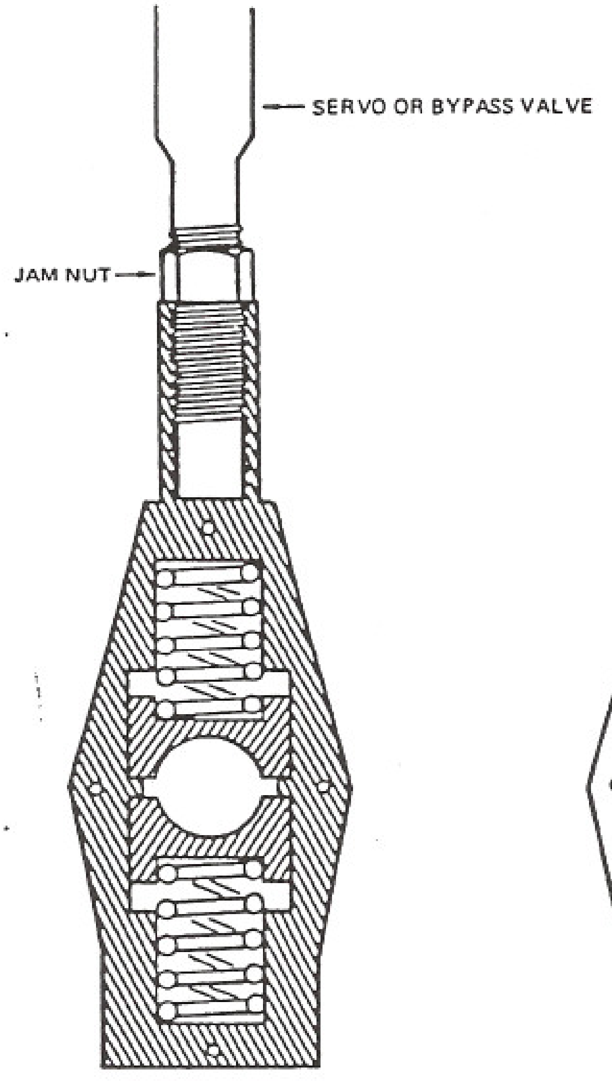
#1 top

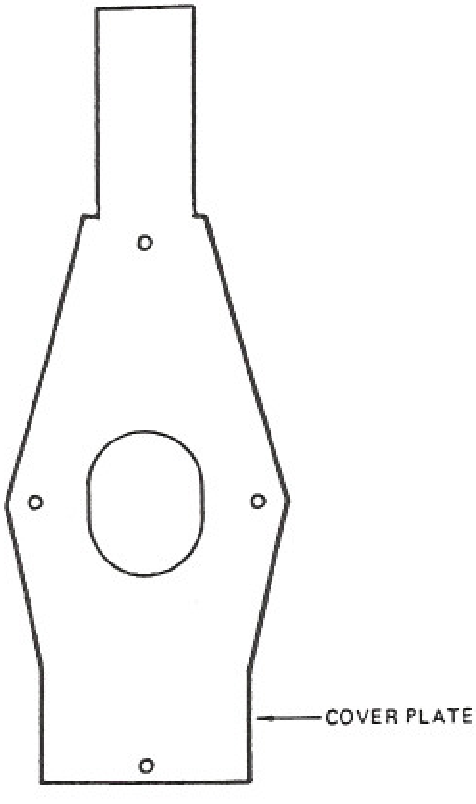
#1 pump
3 servos
+ T/R

#2
3 main
servos

#2
bottom.

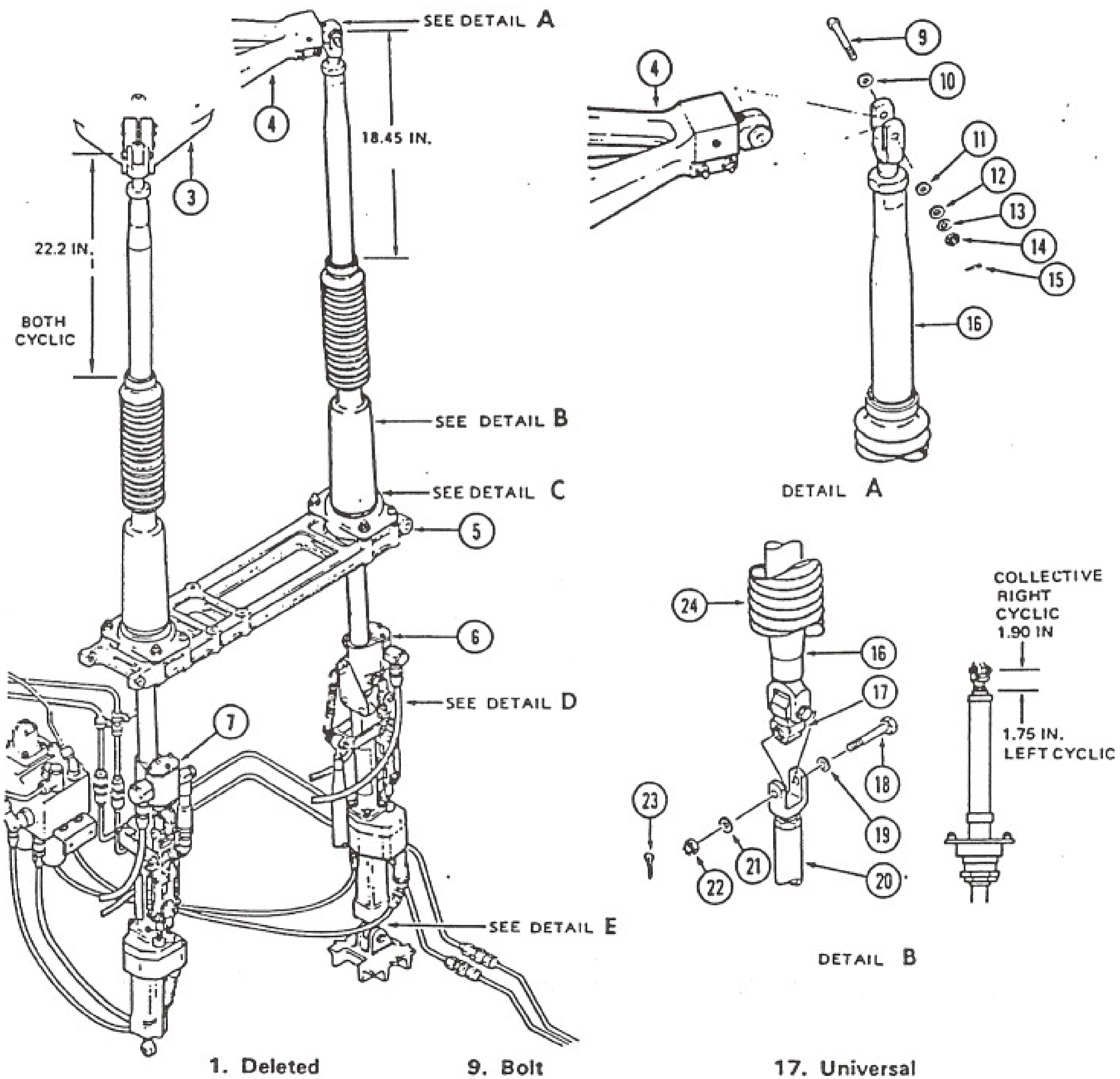
SERVO AND BYPASS VALVE LINKAGE





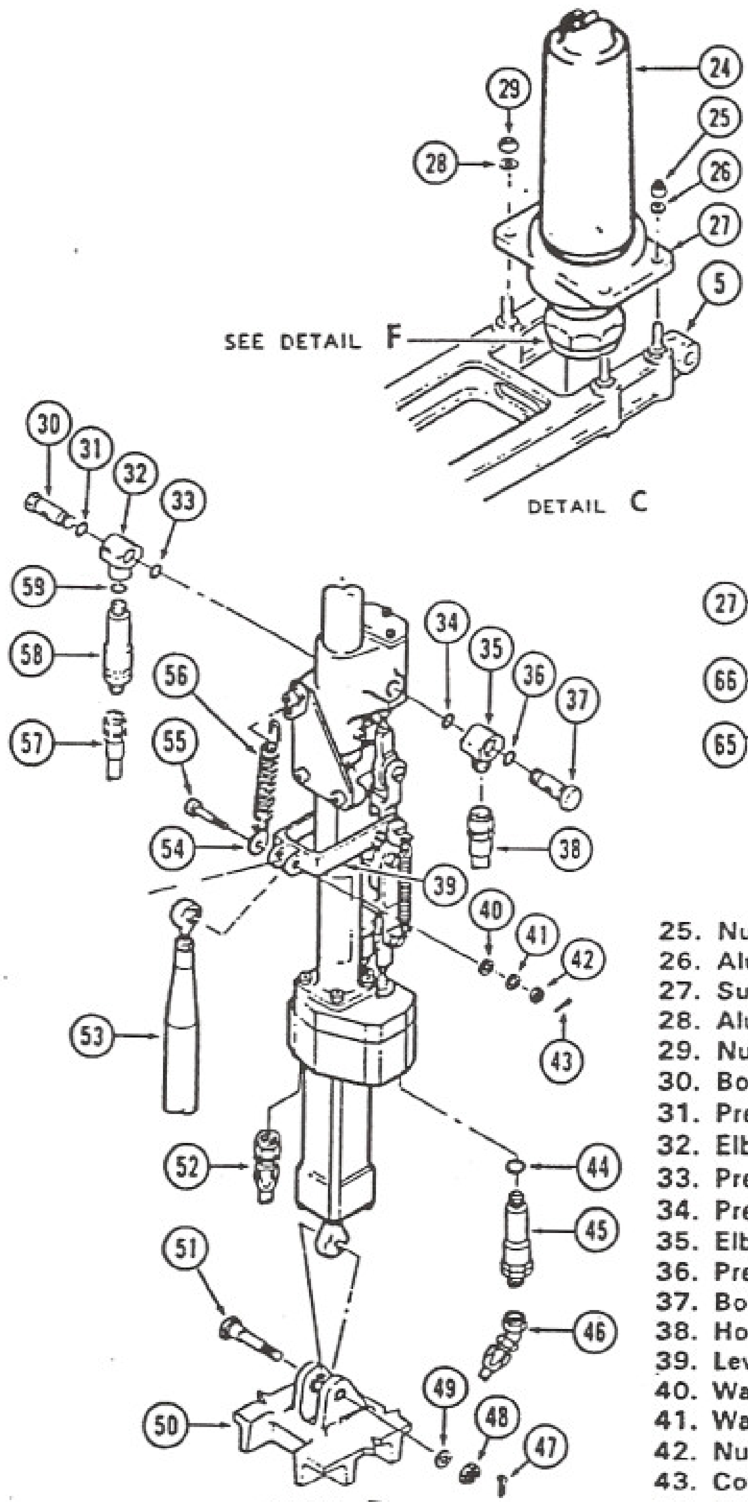
Bell

DUAL SERVO ACTUATOR INSTALLATION (SHEET 1 OF 2)



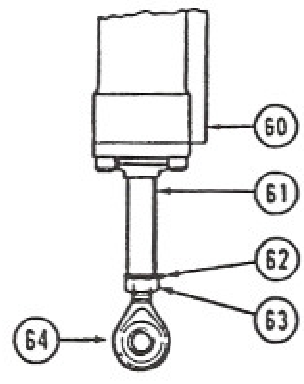
1. Deleted
2. Deleted
3. Swashplate horn
4. Collective lever
5. Support
6. Collective actuator
7. Left cyclic
8. Deleted
9. Bolt
10. Washer (AN960C516)
11. Washer (AN960C516)
12. Washer (AN960C516)
13. Washer (AN960C516L)
14. Nut
15. Cotter pin
16. Tube
17. Universal
18. Bolt
19. Washer (AN960C516)
20. Upper piston
21. Washer (AN960C516)
22. Nut
23. Cotter pin
24. Boot

DUAL SERVO ACTUATOR INSTALLATION (SHEET 2 OF 2)

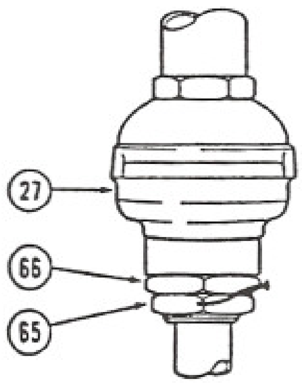


DETAIL C

DETAIL D



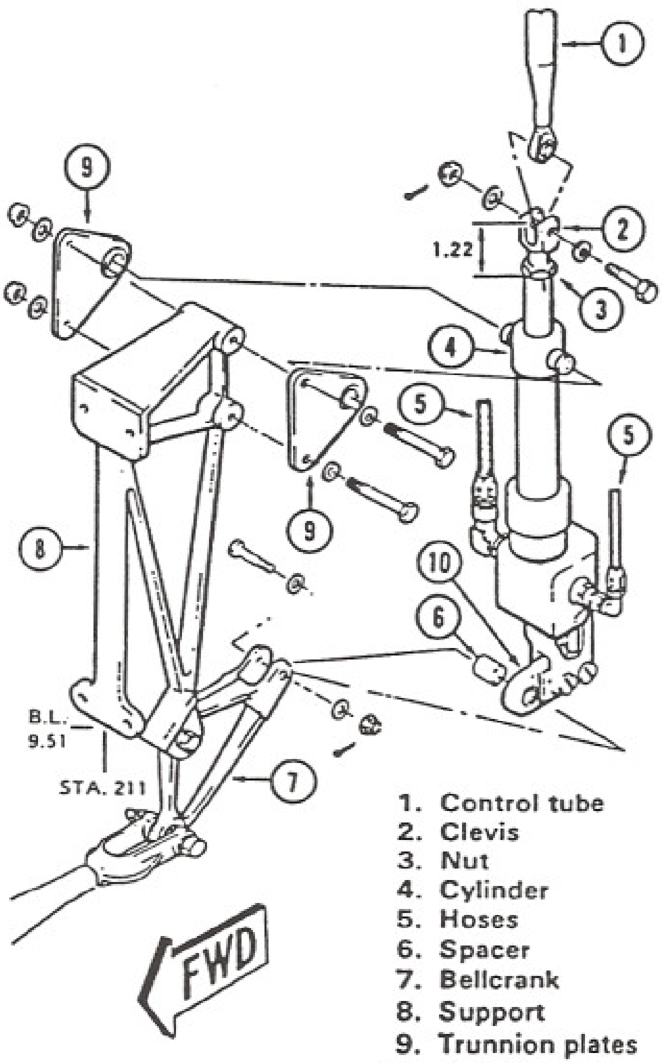
DETAIL E



DETAIL F

25. Nut
26. Aluminum washer
27. Support bracket
28. Aluminum washer
29. Nut
30. Bolt
31. Preformed packing
32. Elbow
33. Preformed packing
34. Preformed packing
35. Elbow
36. Preformed packing
37. Bolt
38. Hose
39. Lever
40. Washer
41. Washer
42. Nut
43. Cotter pin
44. Preformed packing
45. Bypass check valve
46. Hose
47. Cotter pin
48. Nut
49. Aluminum washer
50. Support
51. Bolt
52. Hose
53. Tube
54. Spring clip
55. Bolt
56. Spring (collective only)
57. Hose
58. Bypass check valve
59. Preformed packing
60. Actuator
61. Lower piston
62. Lock
63. Nut
64. Rod end bearing
65. Nut
66. Nut

ANTI-TORQUE SERVO ACTUATOR INSTALLATION

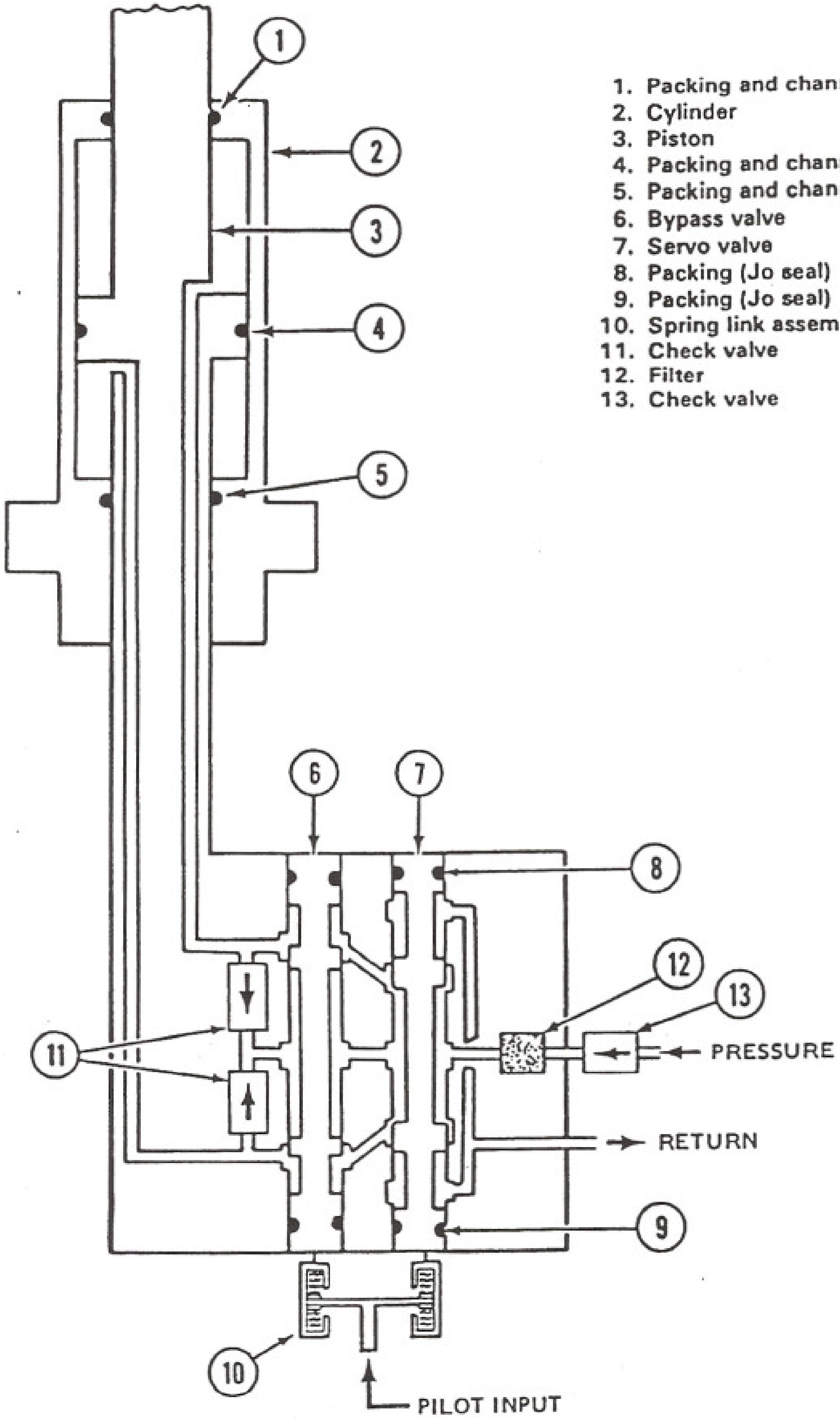


1. Control tube
2. Clevis
3. Nut
4. Cylinder
5. Hoses
6. Spacer
7. Bellcrank
8. Support
9. Trunnion plates
10. Cylinder lever

212001-29C

Bell

ANTI-TORQUE SERVO ACTUATOR HYDRAULIC SCHEMATIC



1. Packing and channel seal
2. Cylinder
3. Piston
4. Packing and channel seal
5. Packing and channel seal
6. Bypass valve
7. Servo valve
8. Packing (Jo seal)
9. Packing (Jo seal)
10. Spring link assembly
11. Check valve
12. Filter
13. Check valve

FUEL SYSTEM

DESCRIPTION

The fuel supply is contained in five separate tank cells. The three nonself-sealing aft tank cells supply fuel to the two lower independent self-scaling tanks, which individually serve as supply sources for each engine power section. Each under-floor tank is equipped with: a sump; a submerged electric motor-driven boost pump; a flow-actuated switch connected to a FUEL BOOST (ENG 1 or 2) caution panel segment to signal if pump is inoperative; a float switch connected to a FUEL LOW caution panel segment; a sump drain valve which can be electrically actuated by a push-button on the side of the fuselage; a lateral baffle with a flapper valve allowing front-to-rear flow, and an ejector-type pump mounted on the front wall and using boost pump flow to send fuel continuously back over the baffle to the rear portion of the cell to assure maximum usability of fuel in all flight positions. A manual drain valve is also provided in the forward compartment of the cell.

The system filler cap is on the right-hand aft tank cell. All cells are interconnected, but the interconnect lines between the under-floor tanks are normally kept closed by electrically-controlled valves. Defueling valves are provided on the aft interconnect line below each under-floor tank sump. Vent lines from all cells are connected to a dual vent system equipped with siphon-breaker valves. Fuel quantity gage probes are located in the center aft tank cell and in forward and rear compartments of both under-floor tanks. Capped connections, for use with either of two auxiliary fuel tank kits, are provided on system vent lines and on crossover fittings between forward and aft cells.

The fuel pressure line from each lower tank boost pump passes through a directional flow check valve and an electrically operated shutoff valve to the engine power sectionllocated on the same side of the helicopter. Check valves and shutoff valves have internal bypass provisions to relieve thermal expansion of trapped fuel. A pressure transmitter in each line serves the pressure gage for that engine system. A crossfeed line between the two pressure lines has an electrically controlled valve which remains closed in NORMAL position of the FUEL PUMP CROSSFEED switch, but will open automatically if

Low Rotor RPM
Horn + light.
92.6 ± 2

103 RPM
± 2 light ONLY

one boost pump fails and allow the remaining pump to supply both engines. The fuel pump crossfeed valve is powered by 28V DC from essential bus 1 and 2. A three position test switch (TEST BUS 1 - NORMAL - TEST BUS 2) labeled FUEL XFEED is located on the fuel and engine control panel to check valve operation from either bus. The fuel filter in each engine has internal bypass provisions to assure flow in event of clogging, and is connected to a FUEL FILTER caution panel segment for warning of an impending bypass condition. Governor bleed lines equipped with check valves will return excess fuel from each engine fuel control to the aft center fuel cell.

Fuel
477 lbs
most fwd
C.G.

Fuel Notes

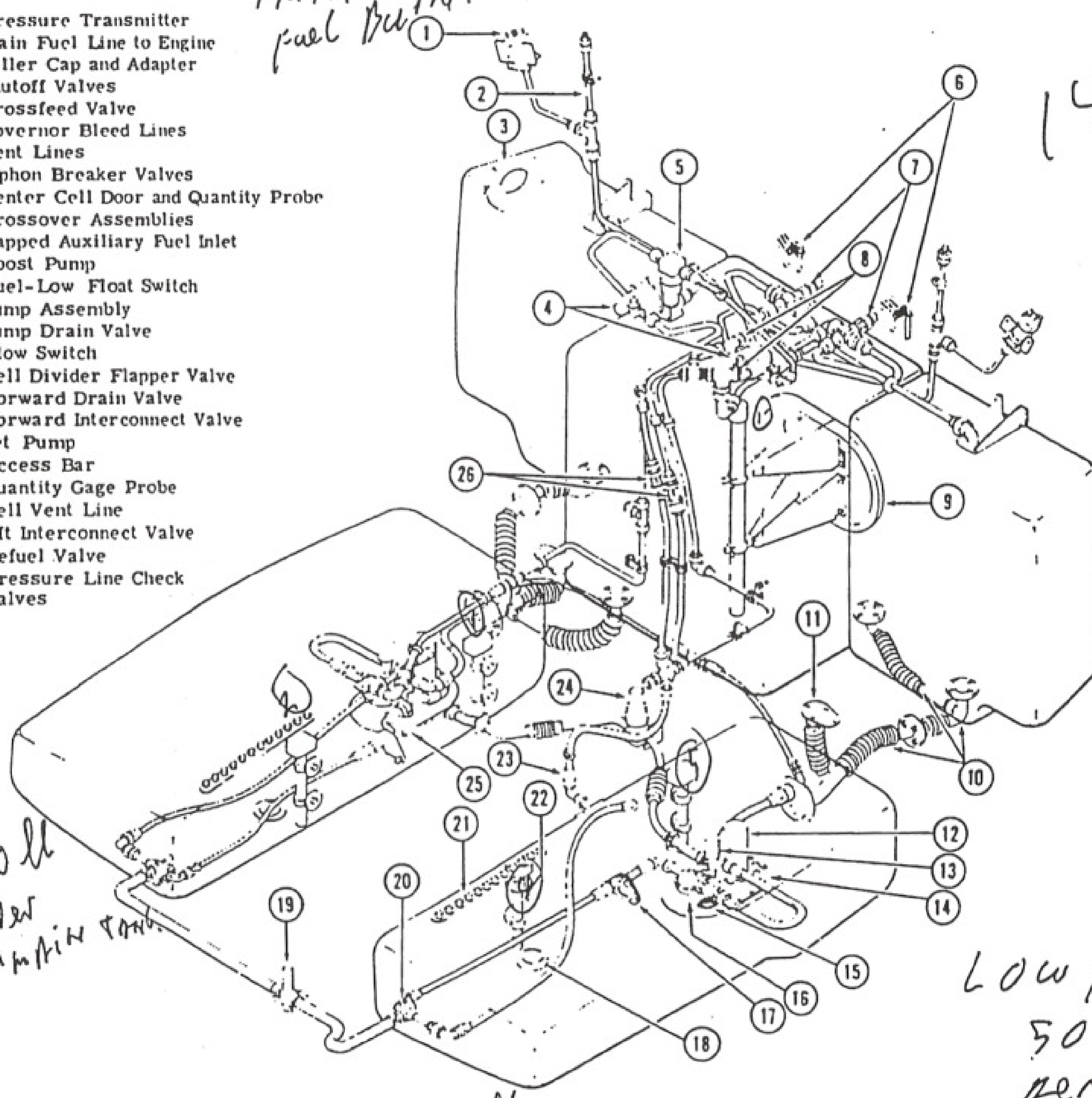
Deactive fuel DRAIN
Heats P3
opens fire wall valve.
ARM Ignition System.

fuel press
4 to 35
10 to 15 normal.

Arms Both bottles to that engine.

① ARM 5 Bottle.
② Closed sept Doors
③ Turns off Gen.
④ Closes Bleed Vent.
⑤ Closse fire wall valve fuel

1. Pressure Transmitter
2. Main Fuel Line to Engine
3. Filler Cap and Adapter
4. Shutoff Valves
5. Crossfeed Valve
6. Governor Bleed Lines
7. Vent Lines
8. Siphon Breaker Valves
9. Center Cell Door and Quantity Probe
10. Crossover Assemblies
11. Capped Auxiliary Fuel Inlet
12. Boost Pump
13. Fuel-Low Float Switch
14. Sump Assembly
15. Sump Drain Valve
16. Flow Switch
17. Cell Divider Flapper Valve
18. Forward Drain Valve
19. Forward Interconnect Valve
20. Jet Pump
21. Access Bar
22. Quantity Gage Probe
23. Cell Vent Line
24. Aft Interconnect Valve
25. Defuel Valve
26. Pressure Line Check Valves



Fuel System Isometric

Fuel Burn 650 lb per hour

10 lb per min fuel burn.

1409 lb

13 lb unusable can each side

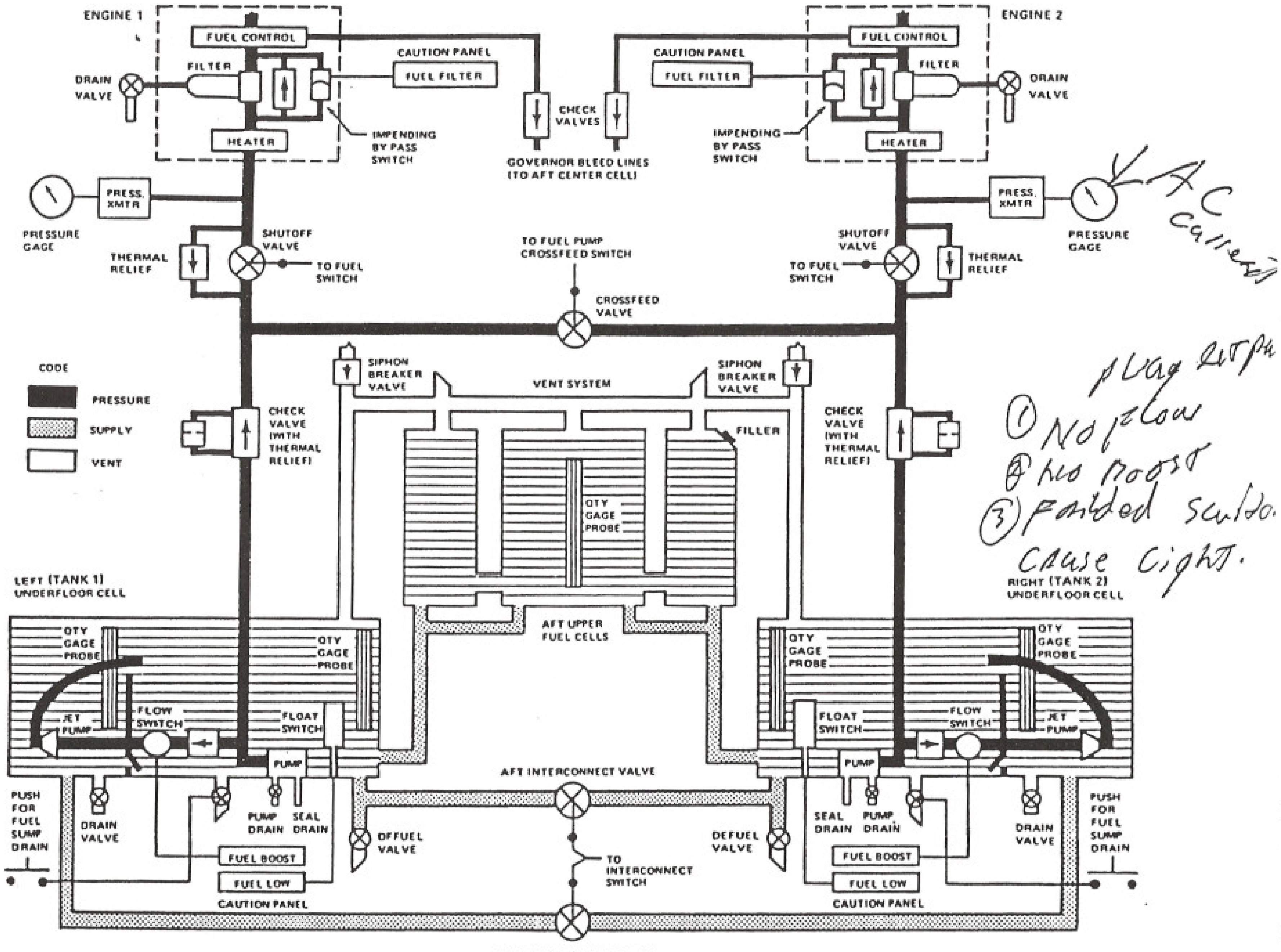
210 min total fuel per Landing

26 lb total unusable.

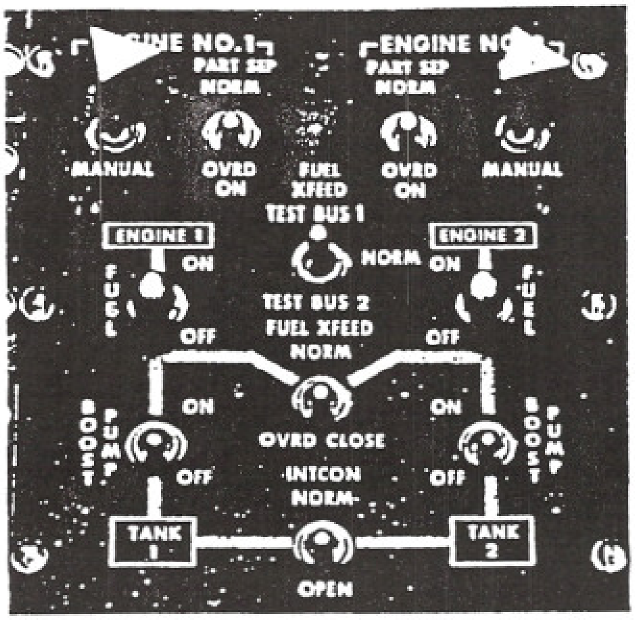
270 lb per main tank

270 lb main tank.

Low fuel 50 lb to 70 lb per side.



Fuel System Schematic



Fuel and Engine Control Panel

Notes

1409 TOTAL fuel   650 per hour

2400 with aux fuel

ELECTRICAL SYSTEM

DESCRIPTION

The primary 28V DC electrical power is supplied by two 30 volt, 200 ampere starter-generators, one mounted on each engine. The output voltage of each generator is monitored and regulated by a DC control unit. The DC control units control paralleled generator operation and provide over-voltage and reverse current protection. Each generator provides power to an individual main DC bus and a common non-essential DC bus. Each main DC bus provides power to two common essential buses through appropriate circuit breaker protection and isolation circuitry. In the event that one generator or engine should fail, the non-essential bus is automatically dropped and all essential DC loads are supplied by the remaining starter-generator. A 24 volt, 34 ampere hour battery provides a back-up source of emergency DC power in the event that both generators should fail. Power for engine starting is provided by the battery, or alternatively, an external 28V DC power receptacle located in the nose of the aircraft. Secondary power is supplied by three identical 250 VA, 115/26 volt, 400 Hz, single phase, solid-state inverters. One inverter is energized by each of the two essential DC buses. These two inverters provide power to their respective 115 volt and 26 volt essential AC buses and are completely independent of each other. The third inverter can be energized from either of the main DC buses and normally supplies power to the 115 volt non-essential bus only. In event of failure of one of the other inverters, the non-essential AC bus is dropped and the third inverter supplies power to an essential AC bus in lieu of the failed inverter. Under normal operation the AC functions of the navigational radios are powered by the No. 1 115/26V AC essential bus. In the event that electrical power is lost to the No. 1 115/26V AC essential bus, with the exception of the ADF, the AC functions of the navigational radios may be transferred to the No. 2 115/26V AC bus.

pressure gauges A/C.

fuel gauges A/C.

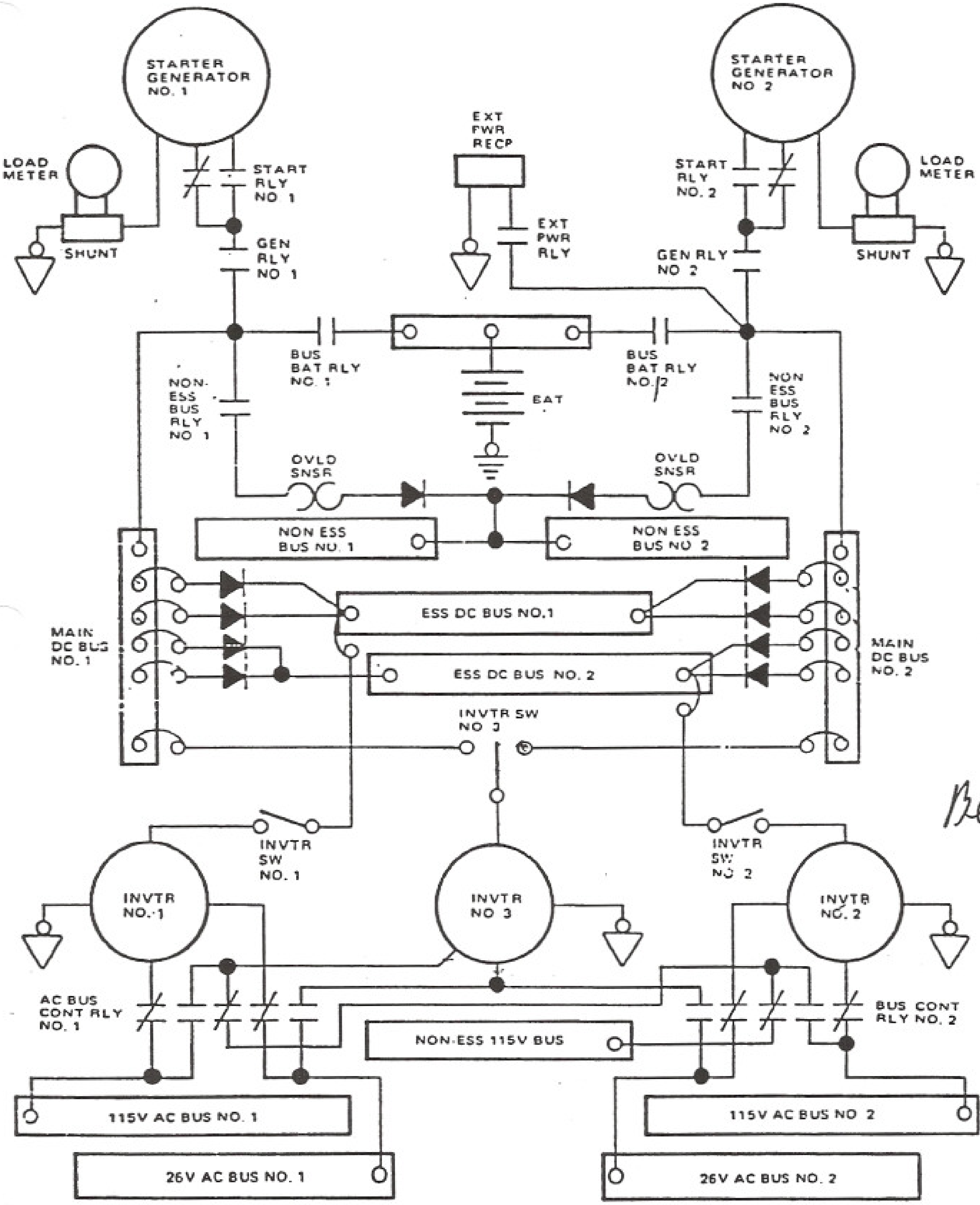
gyros A/C.

~~ADF~~

VOR pointers A/C.

ADF pointers A/C

AFCS → A/C



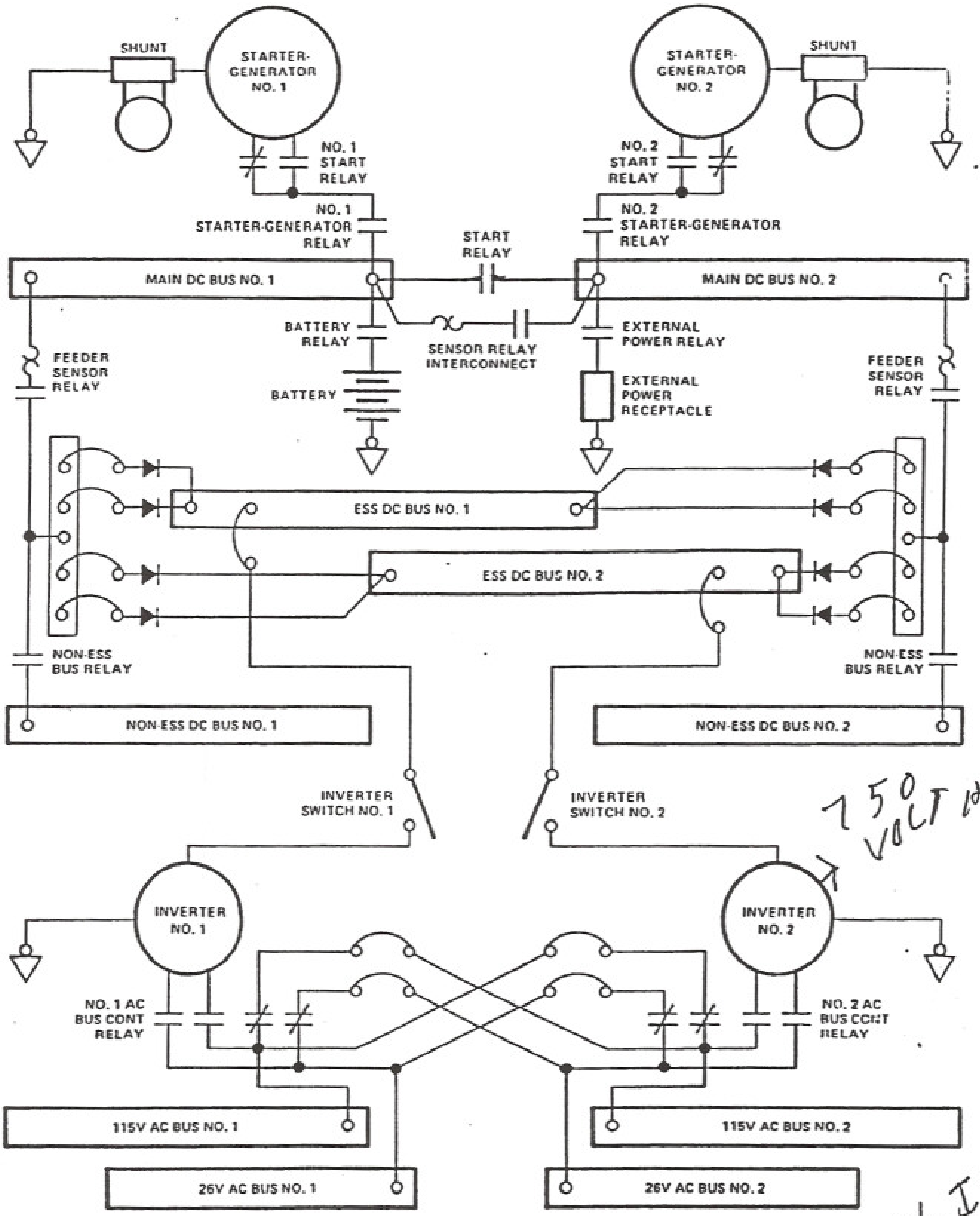
Bell IFR. single Channel

EFFECTIVITY: INSTALLED ON 554 AND SUB. 212099-11

Figure 98-3. Simplified electrical bus wiring schematic

150 amp = 32 hp.

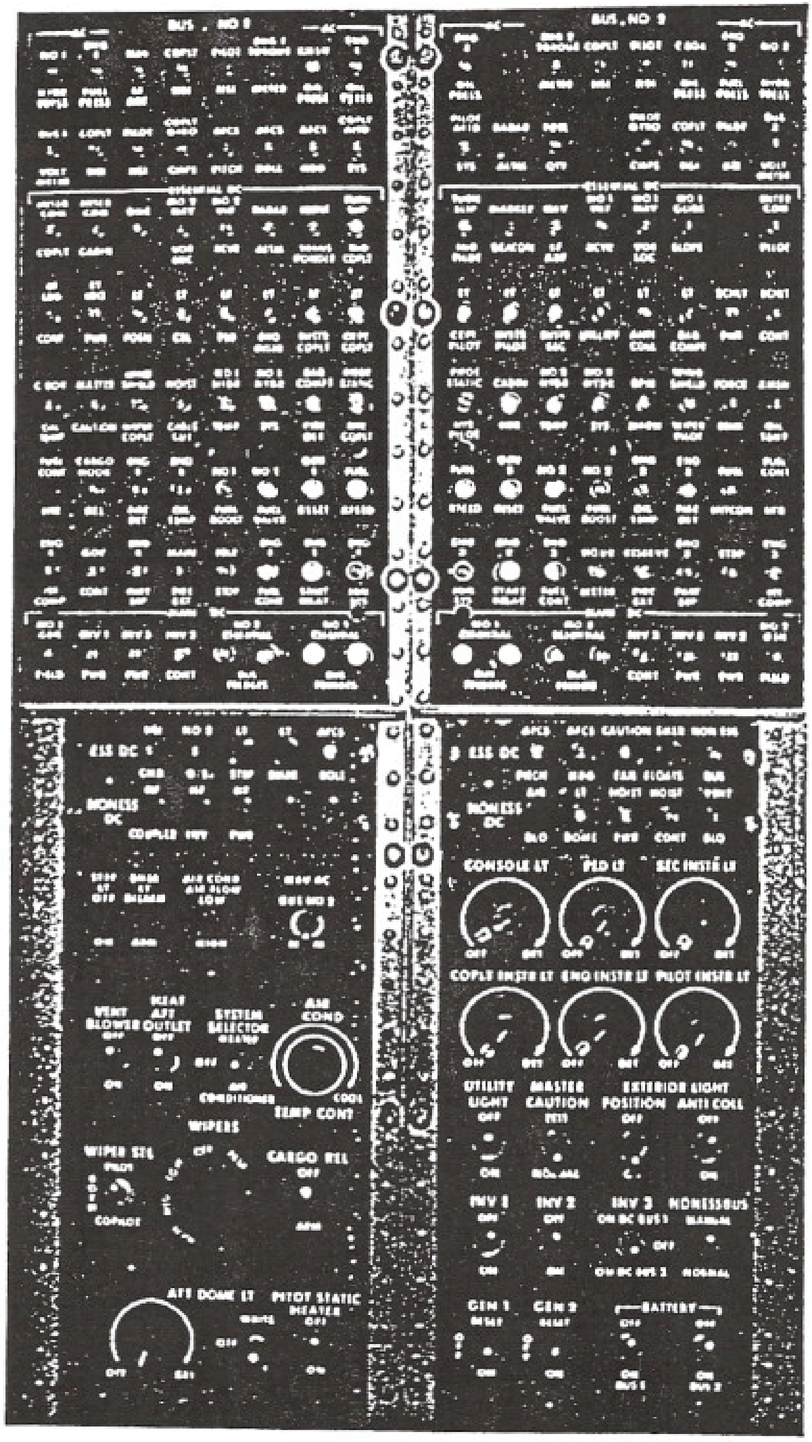
150 amp max gen load. 32 hp. gen on 71%



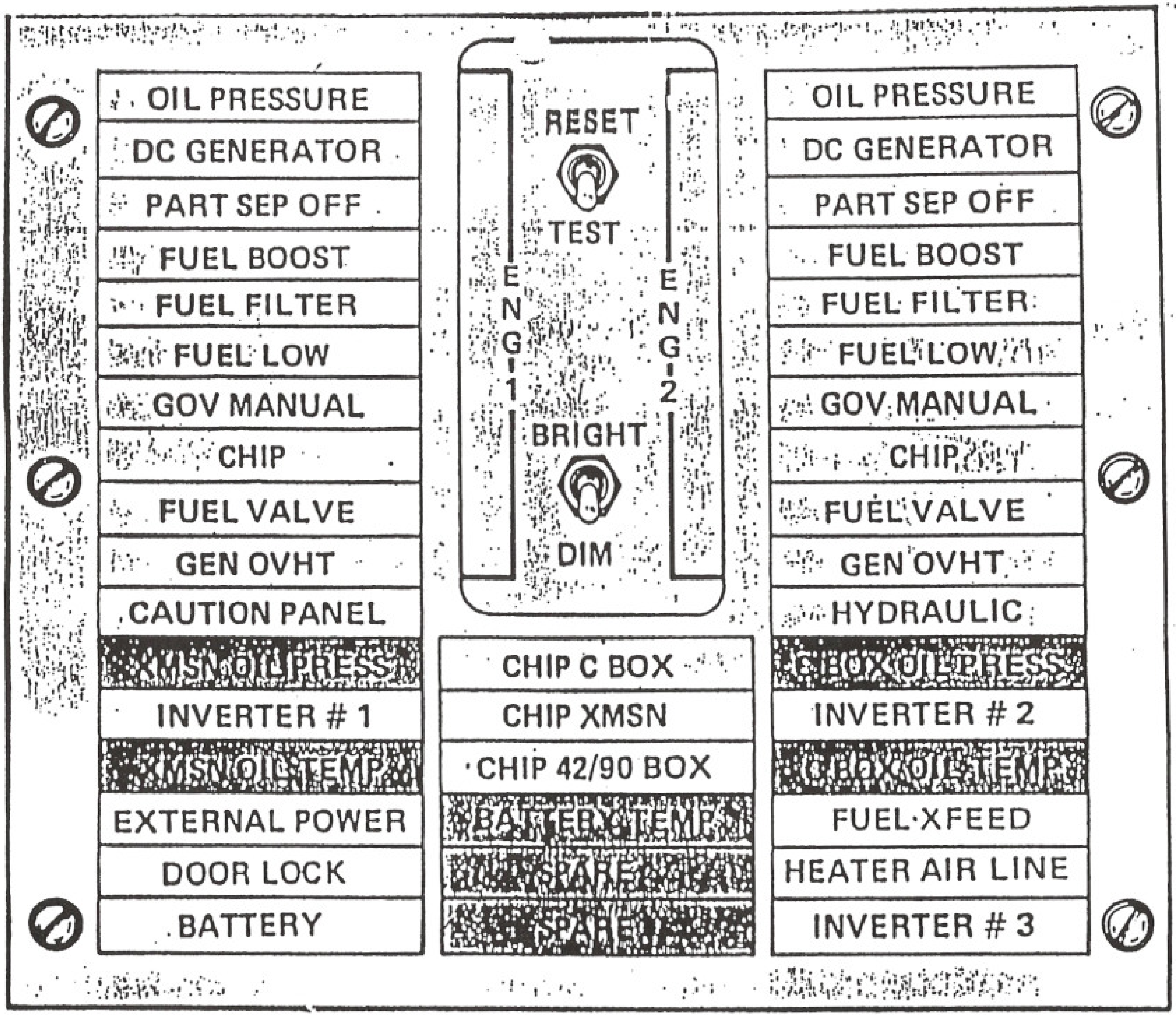
750 VOLT Amp.

Figure 98-3. Simplified electrical bus wiring schematic

S Perry IFR
Dual channel



Overhead Console



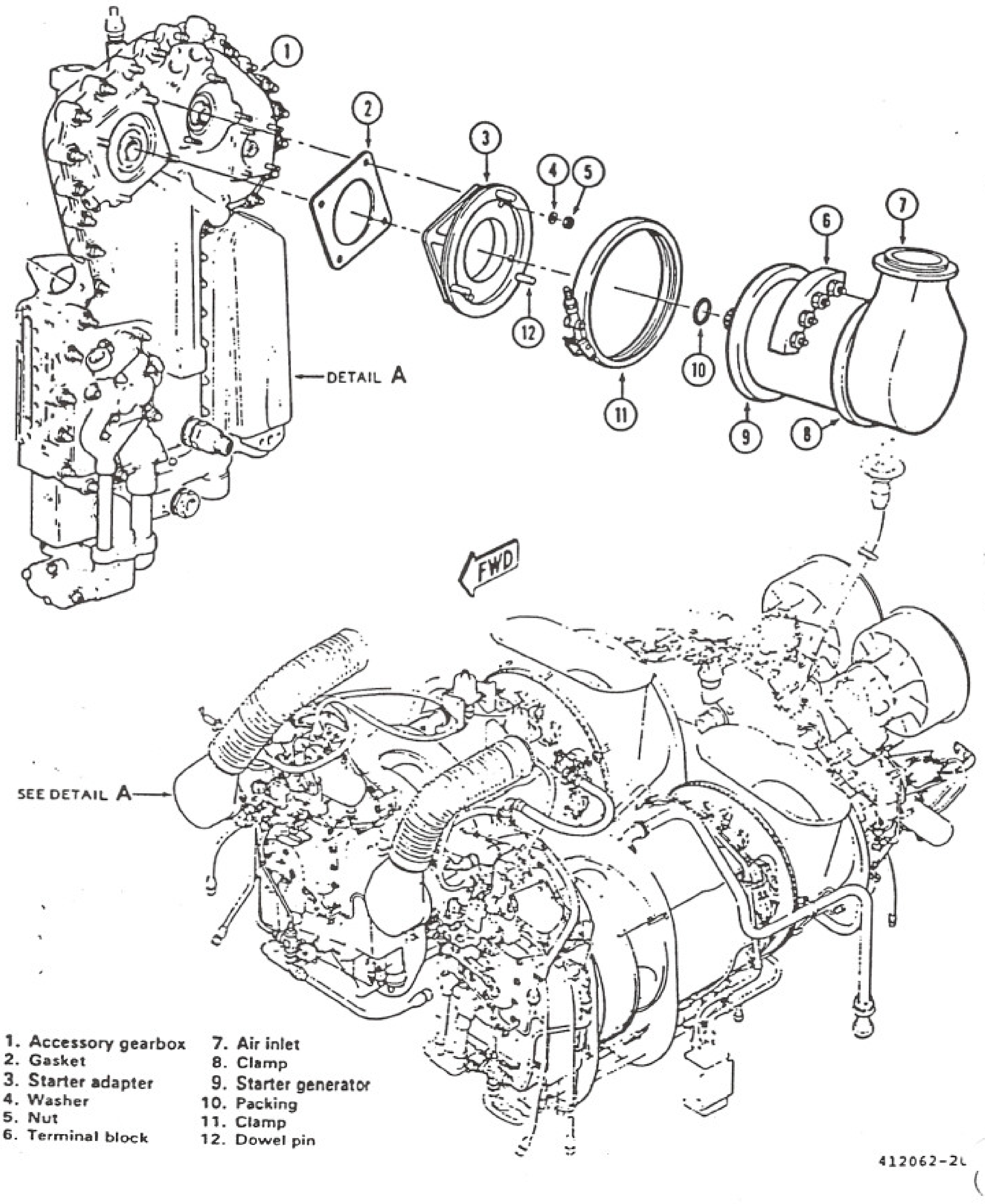
OIL PRESSURE
DC GENERATOR
PART SEP OFF
FUEL BOOST
FUEL FILTER
FUEL LOW
GOV MANUAL
CHIP
FUEL VALVE
GEN OVHT
CAUTION PANEL
XMSN OIL PRESS
INVERTER # 1
XMSN OIL TEMP
EXTERNAL POWER
DOOR LOCK
BATTERY
RESET
TEST
ENG 1
ENG 2
BRIGHT
DIM
CHIP C BOX
CHIP XMSN
CHIP 42/90 BOX
BATTERY TEMP
SPARE
SPARE
OIL PRESSURE
DC GENERATOR
PART SEP OFF
FUEL BOOST
FUEL FILTER
FUEL LOW
GOV MANUAL
CHIP
FUEL VALVE
GEN OVHT
HYDRAULIC
C BOX OIL PRESS
INVERTER # 2
C BOX OIL TEMP
FUEL XFEED
HEATER AIR LINE
INVERTER # 3

D.C. POWER

The primary electrical system is a 28 volt, direct current, single conductor negative grounded system. Power is supplied by two 30 volt 200 amp generators which can be operated individually or in parallel supplying eight power busses. The backup power is supplied by a 24 volt 34 ampere hour nickel cadmium battery capable of supplying a reduced load for approximately 23 minutes. An external power connection supplies a source for continued ground operation without the engines operating.

Bell

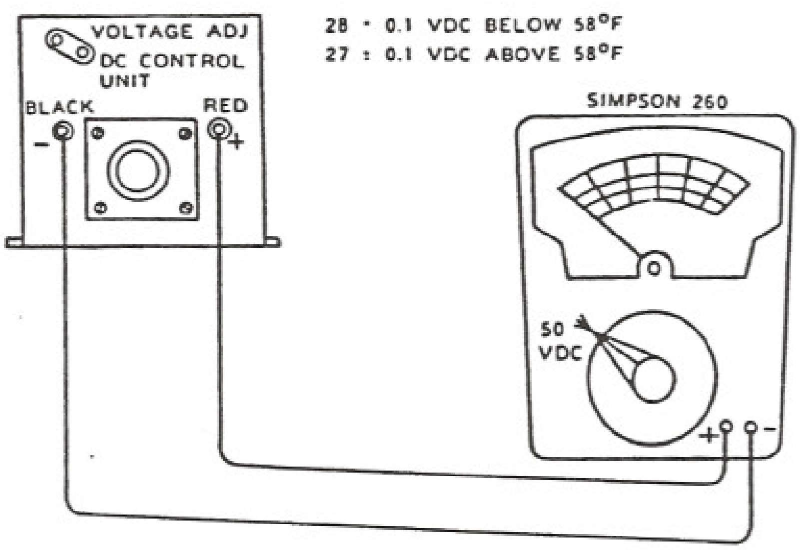
GENERATOR INSTALLATION

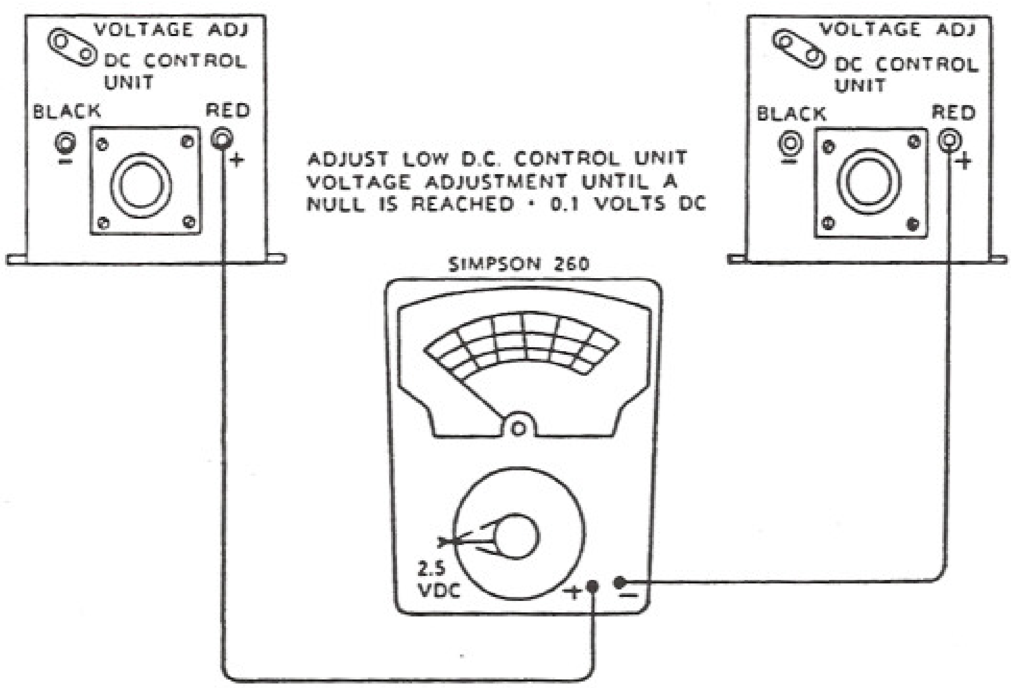


GENERATORS

The starter generators are mounted on the accessory gear case and utilizes the wet spline system. The generators are rated at 200 amps but are downgraded to 150 amps because of cooling.

PARALLELING GENERATORS



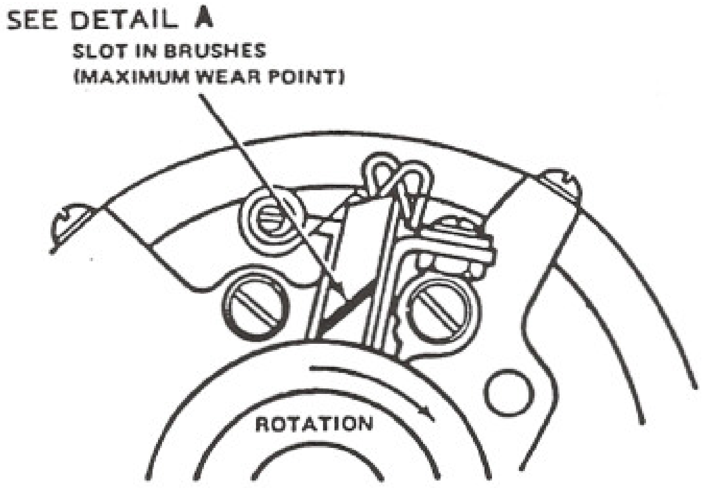


GENERATOR ADJUSTMENTS

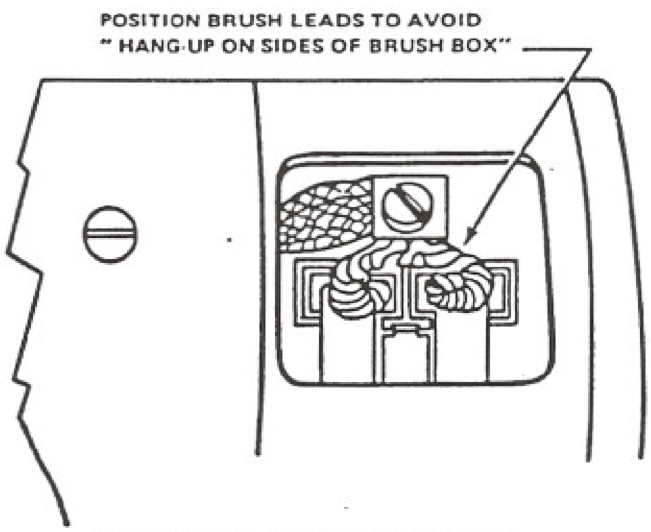
Paralleling the DC power system is accomplished by adjustment of the DC control units for proper voltage regulator setting.

Parallel control provides equal load division between two or more generators operating in parallel by sampling the voltage between the equalizer bus and generator interpole winding.

GENERATOR BRUSH WEAR INDICATOR

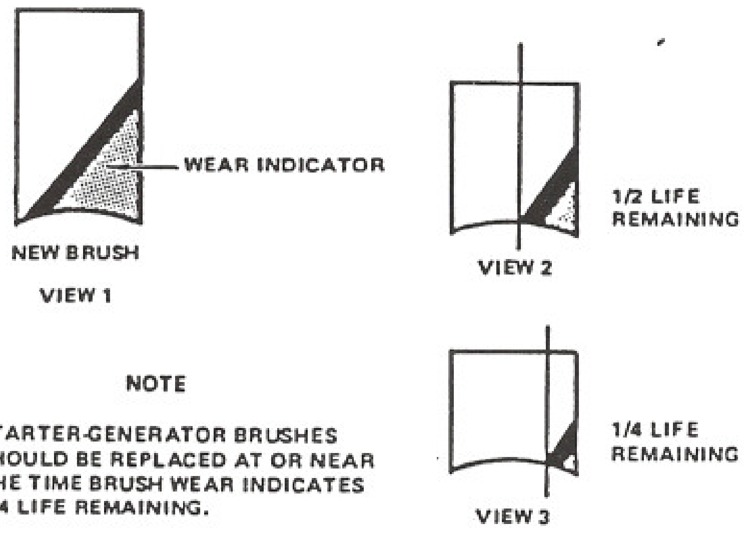


CORRECT POSITION OF BRUSHES AND SPRINGS
WITH REGARD TO ARMATURE ROTATION



CORRECT POSITION OF BRUSH LEADS

BRUSH WEAR INDICATOR



NOTE

STARTER-GENERATOR BRUSHES SHOULD BE REPLACED AT OR NEAR THE TIME BRUSH WEAR INDICATES 1/4 LIFE REMAINING.

7 AVIONICS

AVIONICS SYSTEM

GENERAL

The Model 212 IFR helicopter avionics, communication, and navigation systems include; pilot and copilot Horizontal Situation Indicators (HSI), pilot and copilot attitude direction indicators, dual intercommunication system, dual VHF communication and navigation systems, glideslope and marker beacon system, ADF and DME navigation systems, and ATC transponder.

All communication and navigation radio controls, except the DME, are mounted on the pedestal console between the pilot and copilot stations. The DME controls are mounted in the center of the instrument panel.

Aircraft heading information, from the directional gyro of the Sperry gyrosyn system, is presented on the compass card of the respective pilot and copilot HSI. In addition, each HSI may present VOR or localizer course information from NAV 1 radio, bearing information from NAV 1 - NAV 2 or ADF radios, and glideslope information from NAV 1 radio. NAV 2 VOR or localizer course information and glideslope information is presented on the Course Deviation Indicator (CDI) on the pilot's instrument panel.

Notes