NAVAL AIR TRAINING COMMAND

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SYSTEMS WORKBOOK, ENGINEERING, AND TRANSITION TH-57B/C

HELICOPTER ADVANCED PHASE

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Subj: SYSTEMS WORKBOOK, ENGINEERING, and TRANSITION, TH-57B/C

1. CNATRA P-402 (Rev. 01-15) PAT, "Systems Workbook, Engineering, and Transition TH-57B/C", is issued for information, standardization of instruction, and guidance to all flight instructors and student military aviators in the Naval Air Training Command.

2. This publication is an explanatory aid to the Helicopter and Tiltrotor curriculums and shall be the authority for the execution of all flight procedures and maneuvers herein contained.

3. Recommendations for changes shall be submitted via CNATRA TCR form 1550/19 in accordance with CNATRAINST 1550.6 series.

4. CNATRA P-402 (Rev. 04-11) PAT is hereby cancelled and superseded.

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SYSTEMS WORKBOOK TH-57B/C

P-402

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INTERIM CHANGE SUMMARY

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The following interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

PREFACE

This publication is used for training only and not meant to replace the NATOPS manual. Should a conflict arise, the NATOPS manual will govern. Maintenance personnel should consult current maintenance and overhaul manuals for the latest approved procedures and specifications.

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INTRODUCTION TO THE TH-57

100. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will understand the basic characteristics of the TH-57 and be able to identify the sections of the airframe, including their associated functions and characteristics.

101. ENABLING OBJECTIVES

1. Describe the basic design characteristics and capabilities of the TH-57 helicopter.

2. Recognize the five major sections of the airframe.

    a. Recognize the items associated with the forward section.

    b. Identify the components of the landing gear.

    c. State the main purpose of the cowling section.

    d. State the purpose of the tail boom and identify its associated parts and their functions.

    e. Describe the purpose of the vertical fin and state how it provides directional stability and reduces tail rotor loads.

3. Identify the components of the cargo hook assembly with its associated capabilities and limitations.

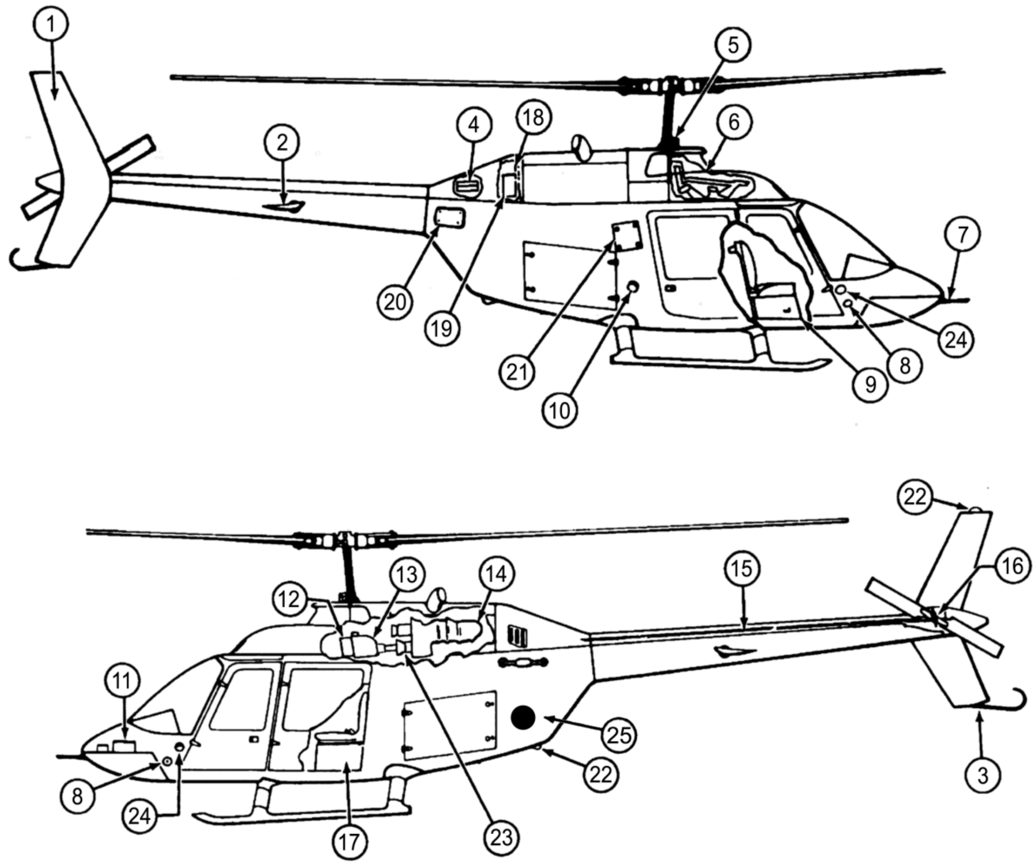
4. Describe the aircraft lighting system and identify the associated lights, switches, and circuit protection.

5. Identify the seat restraints, doors, and caution panels within its associated capabilities and limitations.

102. TH-57B/C AIRFRAME AND GENERAL CHARACTERISTICS

1. GENERAL

The TH-57 is the Navy's designation for the Bell 206B Jet Ranger. The TH-57 (Figure 1-1) is a land-based, skid-configured utility type helicopter designed to land and take off from reasonably level terrain. A Rolls-Royce 250-C20J turboshaft engine powers the main rotor, which is used for lift and thrust, and the tail rotor, which is used to counteract torque and provide yaw control. The maximum takeoff gross weight is 3200 pounds. The maximum forward airspeed at sea level on a standard day is 130 kts, maximum sideward airspeed is 25 kts, and maximum rearward airspeed is 15 kts.



1. Vertical Fin
2. Horizontal Stabilizer
3. Tail Skid
4. Oil Tank - Engine
5. Swashplate Drive Link
6. Cyclic and Collective Servo Actuators
7. Pitot Tube
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13. Transmission Assembly
14. Engine
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17. Passenger Station
18. Oil Cooler (Engine)
19. Oil Cooler Blower
20. Tail Boom Attachment Access Panel
21. Fuel Shutoff Valve Access Panel
22. Anti-Collision Beacon (2)
23. Freewheeling Unit
24. Static Port - Co-Pilot
25. Air Conditioner Intake

Figure 1-1 Components of the TH-57

2. DIMENSIONS

Figure 1-2 depicts the principal dimensions of the TH-57. Note the following dimensions:

a. Main rotor diameter

b. Main rotor to ground clearance

c. Main rotor to tail boom clearance

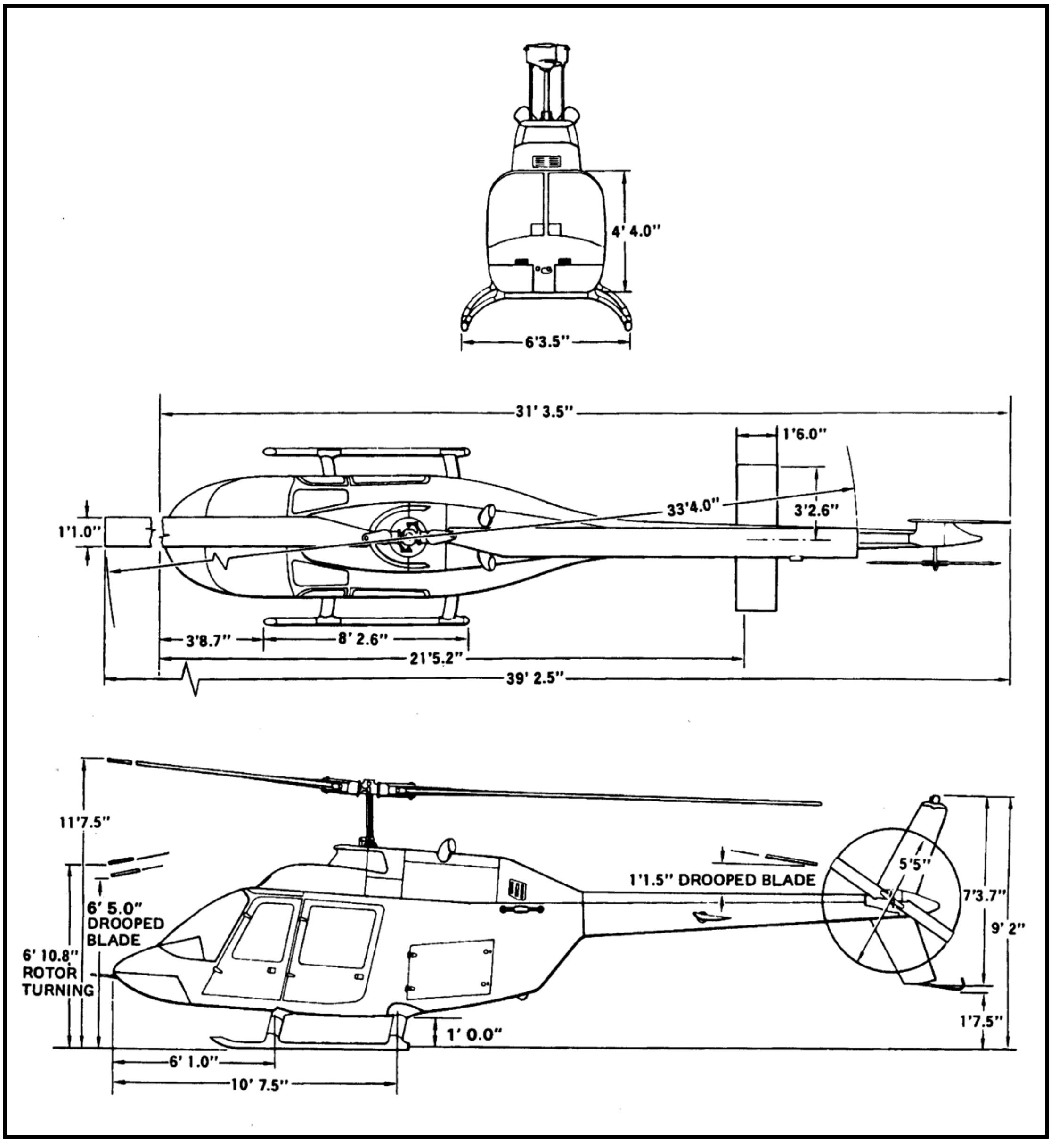

Figure 1-2 TH-57 Dimensions

This concludes our discussion of TH-57 general characteristics.

3. **AIRFRAME**

The airframe is divided into the following sections:

a. Forward/cabin

b. Landing gear

c. Cowling

d. Tail boom

e. Vertical fin

Forward/Cabin. The forward/cabin section (Figure 1-3) is primarily constructed of aluminum honeycomb covered with either fiberglass or aluminum skin. This type construction provides an excellent weight-to-strength ratio and also helps soundproof the cabin area.

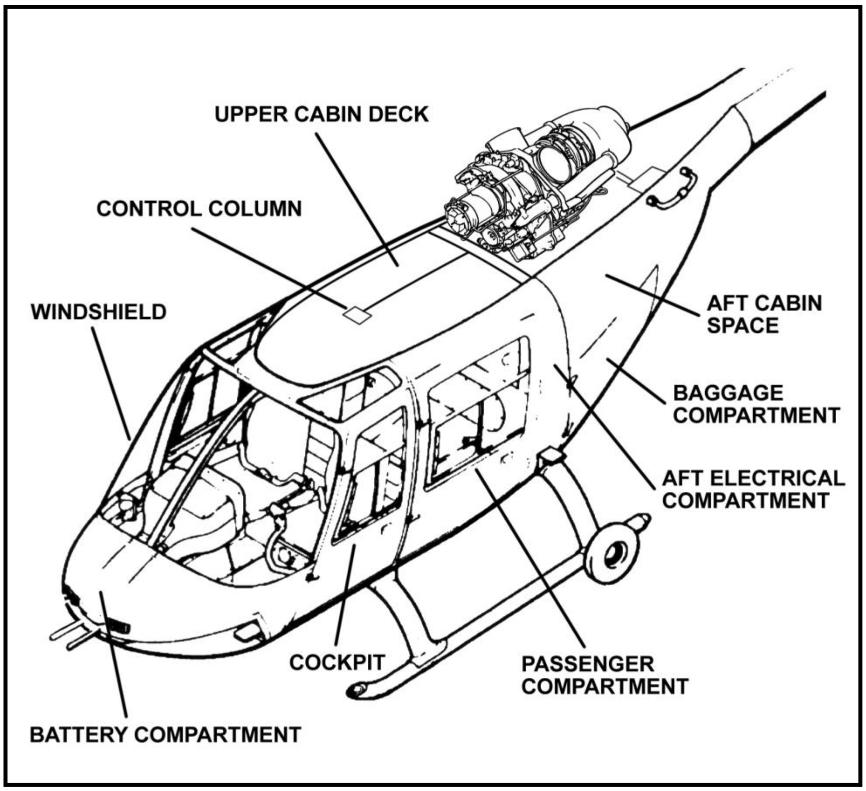

Figure 1-3 Forward Section

Landing gear. The skid type landing gear (Figure 1-4) consists of two aluminum alloy curved cross tubes, two aluminum skid tubes, and a formed steel tail skid. The two curved cross tubes are mounted to the bottom of the forward section by four strap assemblies. The skid tubes have a forward portion curved upward for sliding landings, tow rings for ground towing, and replaceable skid shoes to absorb the wear caused by normal ground contact. Provisions are made for mounting ground handling wheels on the skid tube just forward of the aft cross tube. Also considered part of the landing gear is the formed steel tail skid. This skid is mounted to the base of the vertical fin and protects the tail rotor from ground contact due to a tail low landing. Furthermore, the tail skid is curved upward to prevent it from embedding in the ground during rearward flight. The tail skid is stressed for loads of 200 pounds downward or 400 pounds upward.

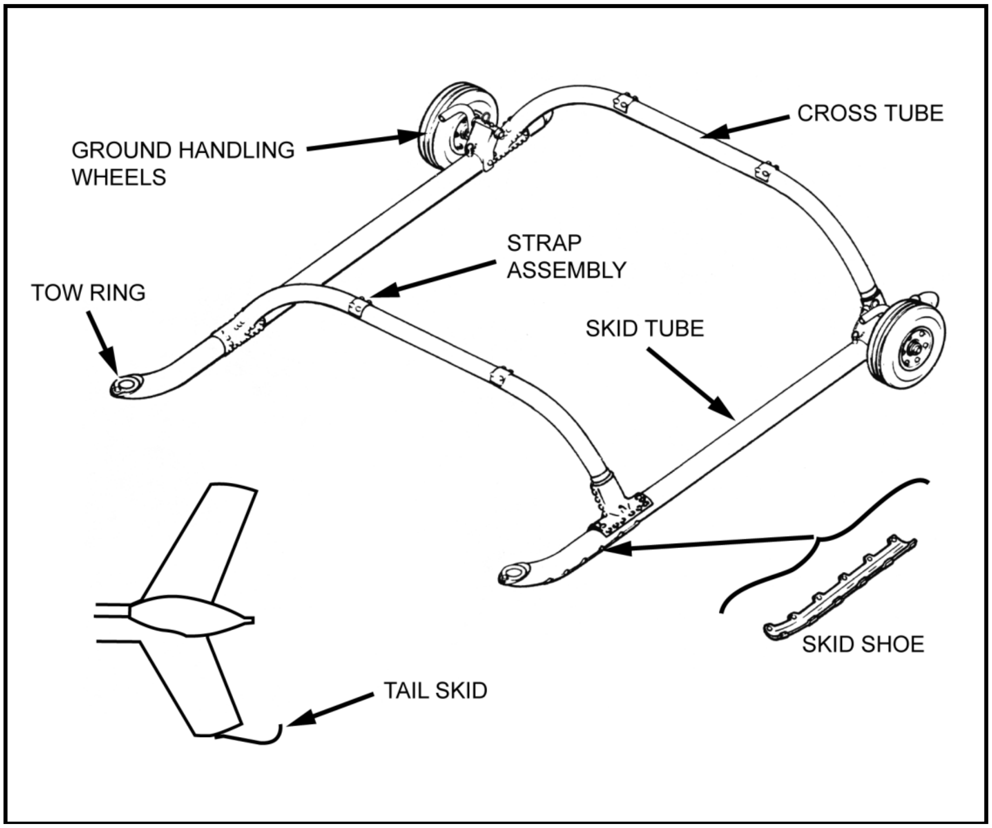

Figure 1-4 Landing Gear

Cowling section. The cowling section (Figure 1-5) streamlines airflow and consists of the forward, induction, engine, and aft fairings. The forward fairing is made of aluminum honeycomb with a fiberglass skin. This fairing reduces sound and vibrations, but primarily streamlines the airflow around the flight controls and transmission. The induction fairing is made of fiberglass to provide weight savings and allow formed compound curves to channel air to the engine. The engine cowling is made of heavy alloyed aluminum and permits access to the engine and engine parts. Finally, we have the aft fairing, which is made of aluminum honeycomb with a fiberglass skin. The aft fairing streamlines the airflow around the engine oil tank and cooler.

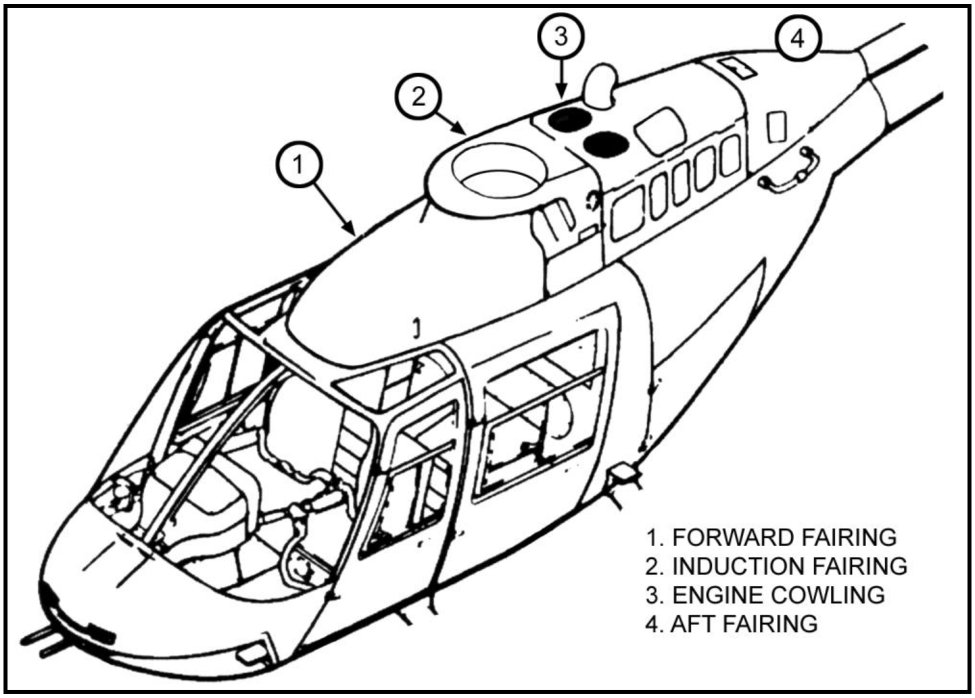

Figure 1-5 Cowling Section

Tail boom. The tail boom (Figure 1-6) is mounted to the rear of the forward section, via a mounting pad and four bolts.

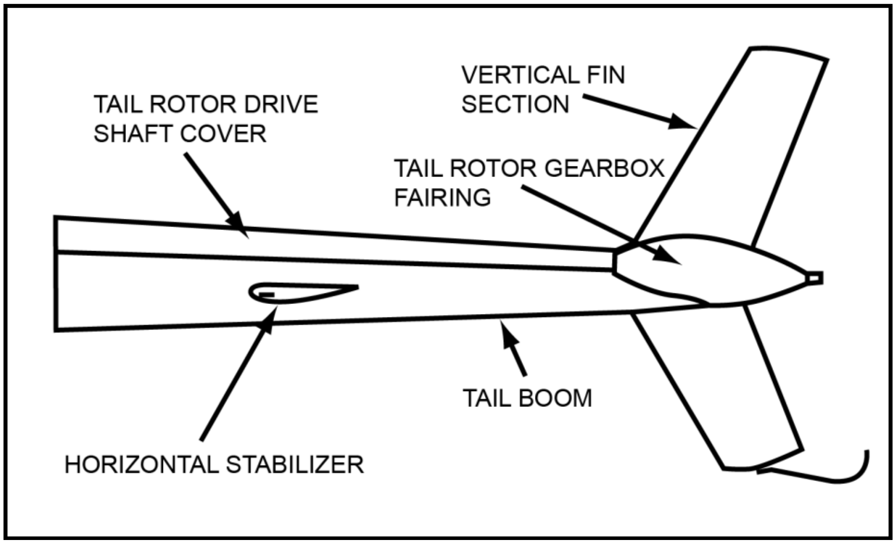

Figure 1-6 Tail Boom Section

With the exception of the first ten inches, the tail boom is a very strong and lightweight full monocoque structure of aluminum alloy. The main purpose of the tail boom is to provide an extended support to mount the tail rotor. Other functions include supporting the horizontal stabilizer, vertical fin section, tail rotor drive shaft, and tail rotor gearbox. The horizontal stabilizer is mounted approximately at the midpoint of the tail boom and it is made with a negative camber. This negative camber creates a download on the tail boom, which enables the aircraft to fly at near level attitude during cruise flight.

Vertical Fin. The vertical fin is a semimonocoque construction made of aluminum honeycomb and aluminum skin that provides directional stability and reduced tail rotor loads at cruise airspeed. This is accomplished by mounting the fin with a 5.5º offset from the longitudinal axis. This offset creates a horizontal lift component that assists in countering torque. (The greater the airspeed, the greater the lift.)

4. CARGO HOOK

The cargo hook (Figure 1-7) consists of a frame and hook assembly with electrical and manual release. ***The cargo hook assembly has a structural weight capacity of 1500 pounds*** and can be mounted on the new B and C models only.

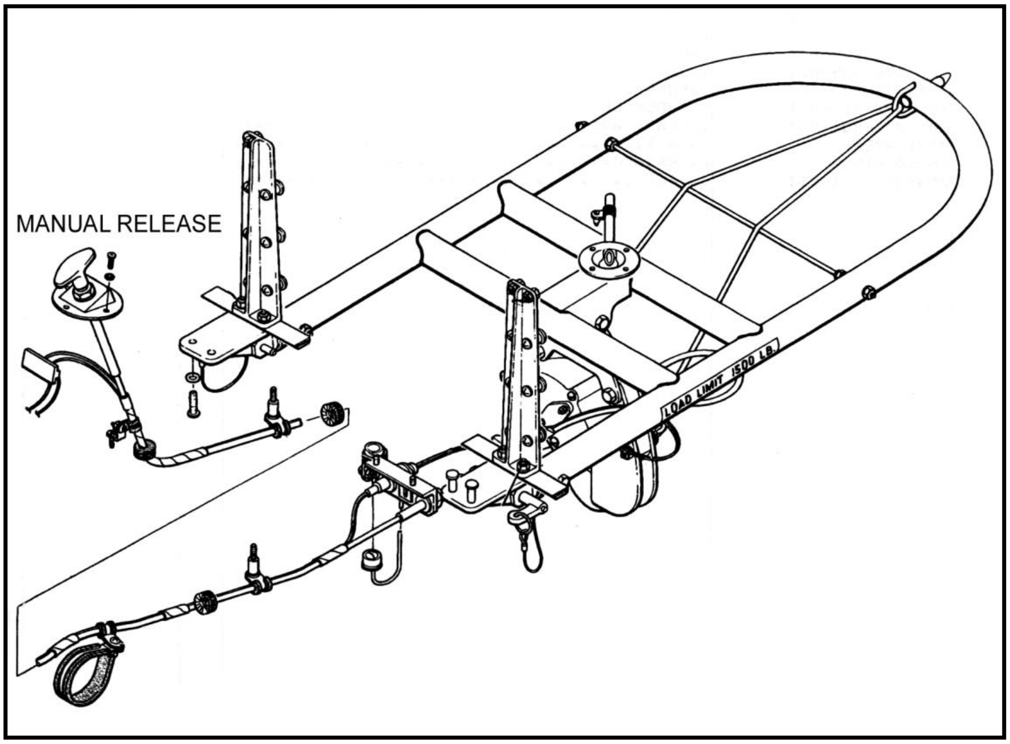

Figure 1-7 Cargo Hook Assembly

The frame attaches to three mounting points under the aircraft. These mounting points are firmly attached to the main structural frame of the aircraft. The entire assembly is mounted so that weight lifted by the cargo hook is lifted in line with the main rotor mast. This minimizes changes in the aircraft center of gravity caused by picking up an external load.

The cargo hook has three release mechanisms (one electrical and two manual). Once the hook is closed, it remains locked until one of these release mechanisms is activated and a down force is applied on the hook itself. ***During normal operations, the electrical release switch on either cyclic is used to release the external load.*** This switch activates a solenoid on the hook assembly that unlocks the hook. The weight of the load then pulls the hook open, and the load is released.

Also in the cockpit is a manual release. This release consists of a “T” handle connected to a cable assembly attached to the hook. Pulling the handle mechanically unlocks the cargo hook and releases the load. The manual release is also called the emergency release because it is used to release a load when the electrical release fails. ***There is one more mechanical release, and it is located on the hook itself.*** This release may be used by a ground handler to release a load; if, the other two releases have failed and cargo must be released to allow the aircraft to land. The two manual releases for the cargo hook are independent systems and will operate at all times, but the electrical release is subject to electrical failure. Power is supplied through a circuit breaker located on the overhead panel. ***Recall that we said the cargo hook is structurally limited to 1500 pounds; but, that is not necessarily the maximum weight you can lift, it may be much less.*** Extreme caution and planning must be exercised anytime an external cargo lift is planned, due to aircraft limitations.

5. LIGHTING SYSTEMS

All aircraft light systems (Figure 1-8) are DIRECT CURRENT (DC) powered. Protection is given to the light circuits by circuit breakers and circuit breaker type switches. Aircraft interior lighting is provided for consoles, overhead placard, and instrument panel. These lights are controlled by the instrument light rheostat, located on the overhead console. The instrument light rheostat controls the level of brightness, with an OFF position. The cockpit map lights are located on both sides of the control column. Each light is mounted to the side of the control column and is connected to a power source by an extension cord. Lamp brightness is controlled by a rheostat switch, located on the end of the light. The lens casing may be rotated to focus the beam. A two-position switch (dim-bright) controls brightness of the caution lights. Two high visibility anti-collision lights are mounted on the exterior of the aircraft.

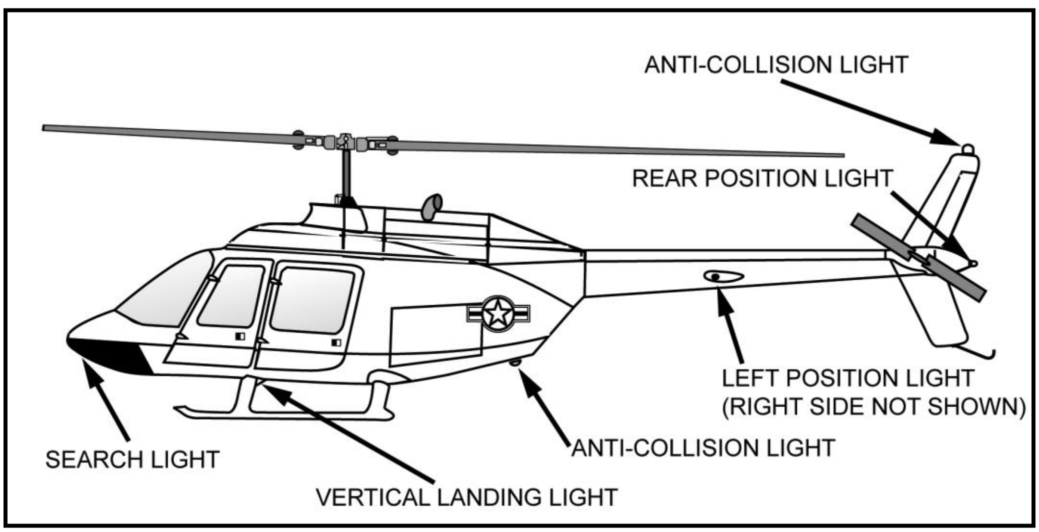

Figure 1-8 Exterior Lighting

One anti-collision light is mounted to the top of the vertical fin and the other is mounted to the bottom of the fuselage, aft of the baggage compartment. Circuit protection and control is provided by the anti-collision light circuit breaker type switch, located on the overhead console. Position lights consist of a red light on the port end of the horizontal stabilizer, a green light on the starboard end of the stabilizer, and on the extreme end of the tail boom is a white position light. Control of the position light system is accomplished by three switches:
a STEADY/FLASH switch, an ON/OFF position light switch, and the BRIGHT/DIM switch.

A vertical landing light is mounted under the fuselage, aft of the forward cross tube, for illumination of the area beneath the helicopter for hovering operations. The light is controlled by a LDG LT switch, located on the overhead console. The light is fixed in position and is not adjustable from the cockpit. Excessive use of the landing light (ten minutes or more during periods of prolonged hovering or taxiing) may cause overheating with a resultant fire hazard. An adjustable searchlight is mounted under the fuselage, just aft of the nose, for illumination of the approach area. The light is controlled by two switches on the pilot's collective head (Figure 2-20). Circuitry is protected by two circuit breakers, labeled SEARCHLIGHT POWER and SEARCHLIGHT CONT; located on the overhead console. The SEARCH LT switch has ON, OFF, and STOW positions. The searchlight control switch controls the direction of the searchlight. The light moves left, right, up, or down corresponding to the direction in which the switch is pushed. The light retains the position it is in when the switch is released. When no longer required, the light may be automatically retracted by placing the SEARCH LT switch to STOW. Once the automatic stow cycle is completed, the switch should be placed in the OFF position.

6. PITOT SYSTEM

The TH-57 Pitot System consists of:

a.	Pitot tube	Supplies impact air to the airspeed indicator
b.	Heater	Electric pitot heater installed on pitot tube and serves to prevent ice from obstructing the pitot tube.
c.	Static ports	Static air pressure for instrument operation is obtained from two static vents located on each side of the fuselage forward of cabin doors.
d.	Tubing	Pitot static system utilizes steel tubing to connect the pitot tube and static ports
e.	Altimeter	Senses static pressure from the static ports.
f.	VSI	Actuated by the rate of the atmospheric pressure change in the instrument and is vented to the static air system.
g.	Airspeed indicator	Measures the differences between impact air pressure from the pitot tube and static pressure from the static vents.

7. SEAT RESTRAINTS, DOORS, AND CAUTION PANEL

Seat Restraints. Pilot and copilot seats are equipped with a lap safety belt and inertia reel shoulder harness with a manual lock-unlock handle located on the left side of both seats. In the unlocked position, the reel cable will extend to allow the pilot to lean forward; however, the reel will automatically lock when the helo encounters a longitudinal impact and a deceleration force of 2 to 3 Gs.

Doors. Both cockpits are accessed via forward hinged doors that are jettisonable in the event of an emergency landing or are removable during the execution of external lifts.

Caution Panel. The caution panel is located on the instrument panel. Illumination of any of the lights on the caution panel alerts the pilot to a system fault or condition. The caution panel is powered by the common BUS (TH-57B) or ESS #2 BUS (TH-57C) and protected by the CAUTION LT circuit breaker.

CHAPTER ONE REVIEW QUESTIONS

1. The maximum gross takeoff weight is

a.	2300 pounds.	c.	3350 pounds.
b.	3200 pounds.	d.	4000 pounds.

2. The main rotor diameter is approximately

a.	22 feet	c.	54 feet.
b.	33 feet.	d.	60 feet.

3. The vertical fin is offset 5.5 to

a.	prevent side slip.	c.	maintain balanced flight.
b.	provide a yaw axis.	d.	assist in countering torque.

4. Match the items in column one with their associated airframe sections in column two.

a.	_____Aft fairing	1.	Forward/cabin section
b.	_____Skid shoes	2.	Landing gear section
c.	_____Cross tubes	3.	Cowling section
d.	_____Induction fairing	4.	Tail boom section
e.	_____Aft electrical compartment	5.	Vertical fin section
f.	_____90º gearbox		
g.	_____Upper cabin deck		
h.	_____Battery compartment		
i.	_____5.5º offset		
j.	_____Horizontal stabilizer		
k.	_____Tail skid		

5. The _____ is made with a _____ camber and creates a download to help maintain a level attitude.

6. The cargo hook has a weight capacity of ___ pounds.

a.	1100	c.	1500
b.	1300	d.	1700

7. All interior lights are controlled by the instrument light rheostat.

a.	True	b.	False

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CHAPTER ONE REVIEW ANSWERS

1. b

2. b

3. d

4. a. 3.
   b. 2.
   c. 2.
   d. 3.
   e. 1.
   f. 4.
   g. 1.
   h. 1.
   i. 5.
   j. 4.
   k. 2.

5. Horizontal stabilizer…negative

6. c

7. False

CHAPTER TWO
ROLLS-ROYCE 250-C20J TURBOSHAFT ENGINE

200. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will have a basic understanding of the design features of the Rolls-Royce 250-C20J turboshaft engine, engine oil system, engine controls, and the nomenclature associated with each.

201. ENABLING OBJECTIVES

1. Identify the type of gas turbine engine used in the TH-57.

   - State the power output of the 250-C20J engine.

2. Identify the four subassemblies of the engine.

   a. Identify the four subassemblies of the compressor.

      - State the three functions served by the front support of the compressor and identify how each function is achieved.

   b. Describe the compressor used in the 250-C20J engine by identifying the components, types of compression utilized, the number of stages of compression used, and where the components are mounted.

   c. State the main purpose of the compressor bleed air system and identify its location.

   d. Trace the path of airflow from the air intake through the engine by identifying the components in the proper sequence with respect to flow.

   e. Identify the type of combustor used in the 250-C20J engine.

      i. Identify the location of the components in the combustion section and state their purpose.

      ii. State the purpose of airflow through the combustor and the amount used for each purpose.

   f. State the purpose of the turbine section in the 250-C20J engine.

      i. Identify the components of the turbine section and state their function.

      ii State what portion of the available energy is used to drive the gas producer and free power turbine sections.

iii. Identify the location and name of the components used for measuring turbine outlet temperature (TOT).

g. Identify the functions of the accessory gearbox.

i. Identify the accessories driven by the gas producer.

ii. Identify the units driven by the power turbine gear train.

3. Identify the type of engine oil system utilized in the 250-C20J engine.

a. State the function and location of each component of the engine oil system.

b. Identify how to determine the engine oil level and why it is important to know the exact level.

c. State how engine oil temperature and pressure information is transmitted to the cockpit.

4. State why fuel metering is important for a turboshaft engine by identifying the problems which can occur if fuel is not metered correctly.

a. Identify the type of fuel control used in the 250-C20J engine and state how it controls engine power.

b. Describe the function of the power turbine governor by stating the engine performance parameters sensed and its connection to the fuel control.

c. State what components control the power turbine governor and the gas producer fuel control.

d. State how the twist grip functions.

e. Describe the droop compensation system by identifying the cockpit controls, engine controls, and its effect on power output.

202. ROLLS-ROYCE 250-C20J TURBOSHAFT ENGINE, ENGINE OIL SYSTEM, ENGINE CONTROLS

The TH-57 engine is an internal combustion gas turbine engine featuring a "free" power turbine. The engine consists of a combination axial-centrifugal compressor, a single "can"-type combustor, a turbine assembly which incorporates a two-stage power turbine and exhaust collector, and an accessory gearbox which incorporates a gas producer gear train and a power turbine gear train. Rolls-Royce 250-C20J engine is a 420 SHP engine. 317 SHP is usable if torque limits are maintained (100% TQ) due to power train limitations.

The four subassemblies of the engine (Figure 2-1) are:

1. Compressor section

2. Combustion section

3. Turbine section

4. Accessory gearbox section

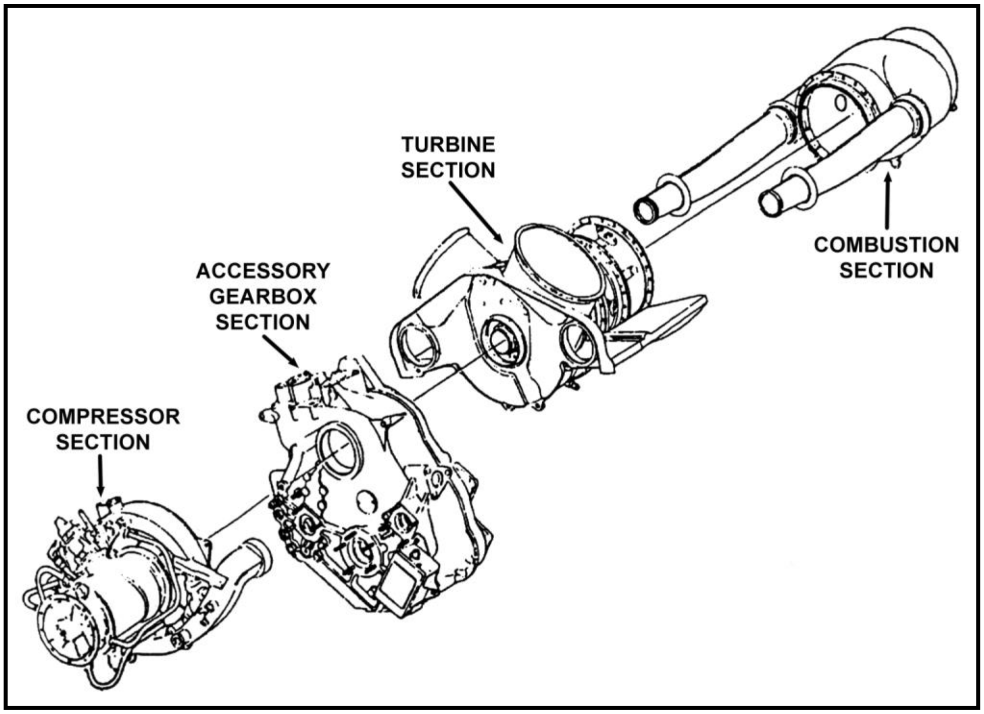

Figure 2-1 Turboshaft Engine

203. COMPRESSOR SECTION

The four subassemblies (Figure 2-2) are:

1. Front support

2. Compressor rotor blades and wheels

3. Case assemblies

4. Diffuser scroll

The front support section is an aerodynamically designed air inlet with seven hollow struts and front bearings for the rotor. The hollow struts serve as part of the anti-ice system, which will be discussed later in this chapter. The struts serve as inlet guide vanes, which ensure ambient air strikes the first stage compressor at the proper angle.

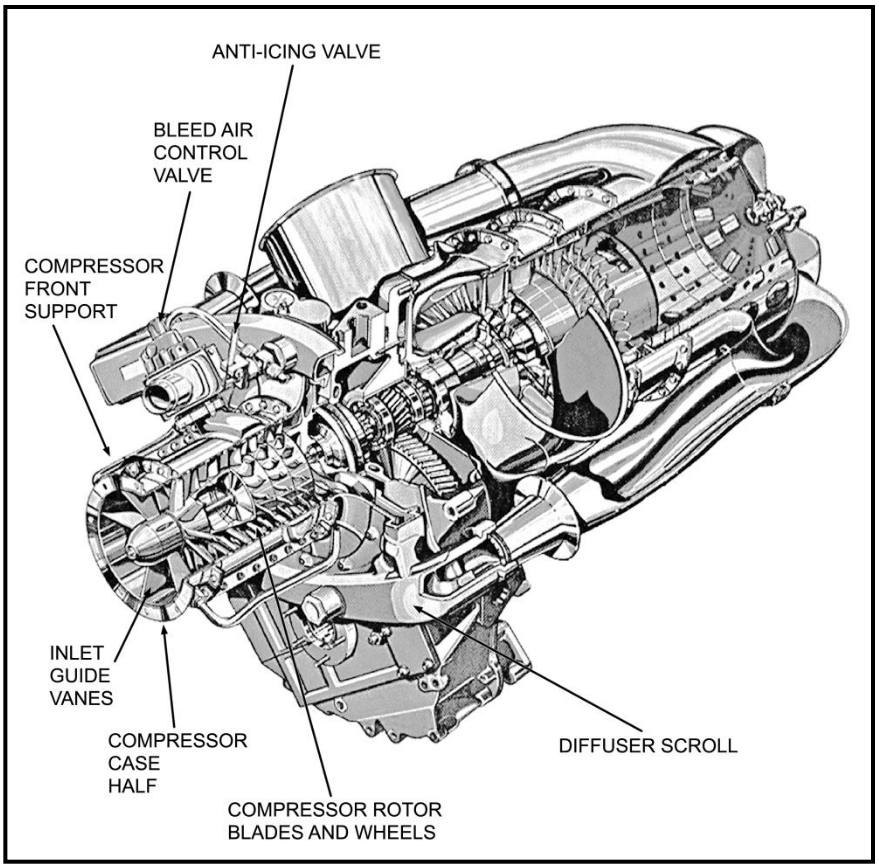

Figure 2-2 Compressor Section

The 250C-20J engine is equipped with a ***six-stage axial compressor and one-stage centrifugal compressor.*** A stage of an axial compressor consists of a set of airfoil-shaped blades on a rotating disc called a ***rotor***, followed by a set of airfoil-shaped stationary blades mounted to the compressor case called ***stators*** (Figure 2-3).

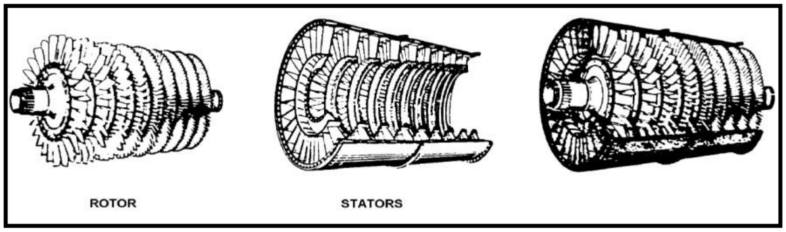

Figure 2-3 Typical Axial Compressor

The rotors accelerate the airflow while the stators slow the air (increase static pressure) and direct it to the next stage of rotors. Each stage of the axial compressor acts like a pump, moving the air through the compressor as the cross-sectional area decreases.

After passing through and being compressed by the six stages of the axial compressor, the air enters the centrifugal compressor. The centrifugal compressor compresses air by using a rotary impeller to centrifugally accelerate the air. The accelerated air is slowed (increases static pressure) and collected in the diffuser scroll. By the time the air is collected in the diffuser scroll, it has been compressed to 6.5 times ambient pressure and has risen to a temperature of 500º Fahrenheit.

A bleed air control valve is mounted on the compressor case at the 5th stage of the compressor. This valve bleeds air from the 5th stage of the compressor during starting, acceleration, and at low compressor pressure ratio operation. This system includes a bleed air control valve attached to the compressor case and the necessary plumbing between the diffuser scroll and the bleed air control valve. The bleed air control valve is a modulating pneumatic control which bleeds 5th stage pressure over a specific range o the ratio of compressor discharge pressure to ambient pressure. This valve bleeds 5th stage pressure at low pressure ratios to unload the compressor in order to prevent compressor stall and surge. The compressor bleed air system is an entirely automatic system (Figure 2-4).

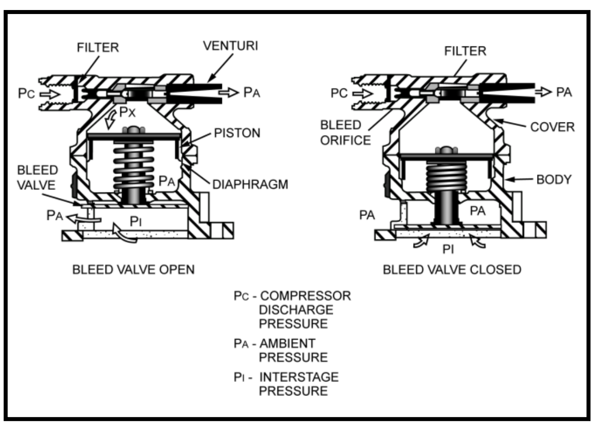

Figure 2-4 Bleed Air Control Valve

The diffuser scroll has ports from which air may be bled for anti-icing and cabin heat, and a port through which compressor discharge air pressure is sensed by the fuel control system. Air not bled for these purposes is carried to the combustion sections by two air transfer tubes.

204. COMBUSTION SECTION

The combustion section is where the compressed air is mixed with fuel and ignition takes place. The 250-C20J engine is equipped with a single "can" type combustion chamber. The combustion section consists of the outer case and an inner liner (Figure 2-5). Mounted at the aft end is the fuel nozzle and igniter plug. A burner drain valve is located at the lowest point in the combustion chamber. During normal operation, combustion chamber pressure keeps the valve closed. Pressurized air leaves the air transfer tubes and enters the outer combustion case.

Approximately 75% of the air passes between the inner liner and combustion case, which is used for cooling the combustion chamber. The other 25% enters the combustion liner and is mixed with fuel sprayed from the fuel nozzle. During starting, the fuel-air mixture is ignited by the capacitor-type igniter plug located adjacent to the fuel nozzle. ***Once the engine is started, combustion is self-sustaining.*** When the combustion takes place, the gases expand rapidly and are expelled into the turbine section (Figure 2-6).

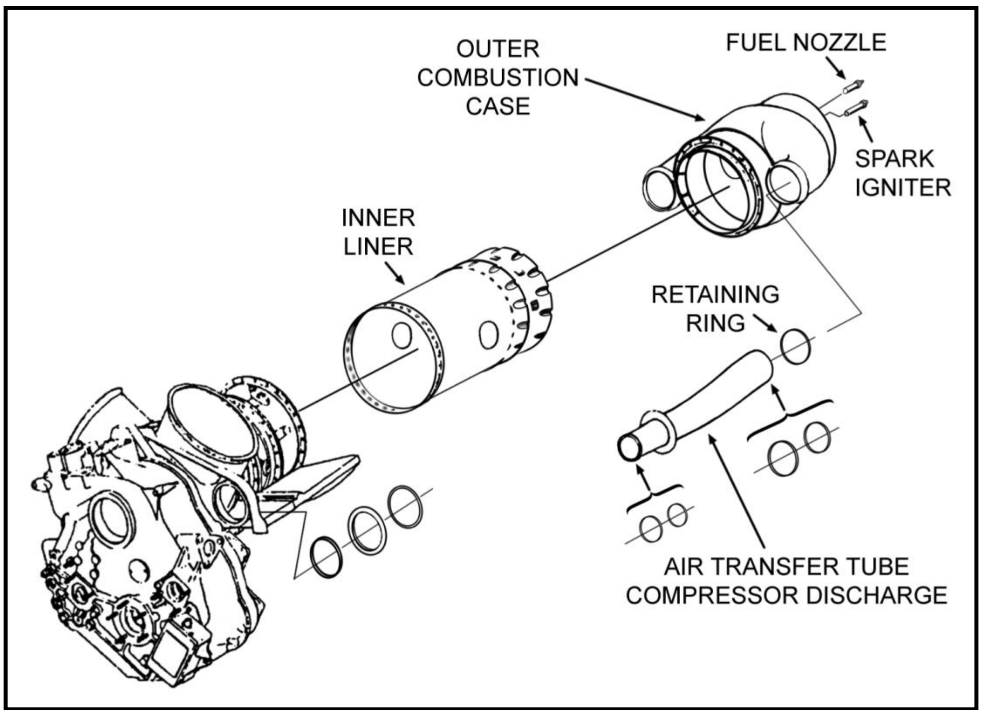

Figure 2-5 Combustion Section

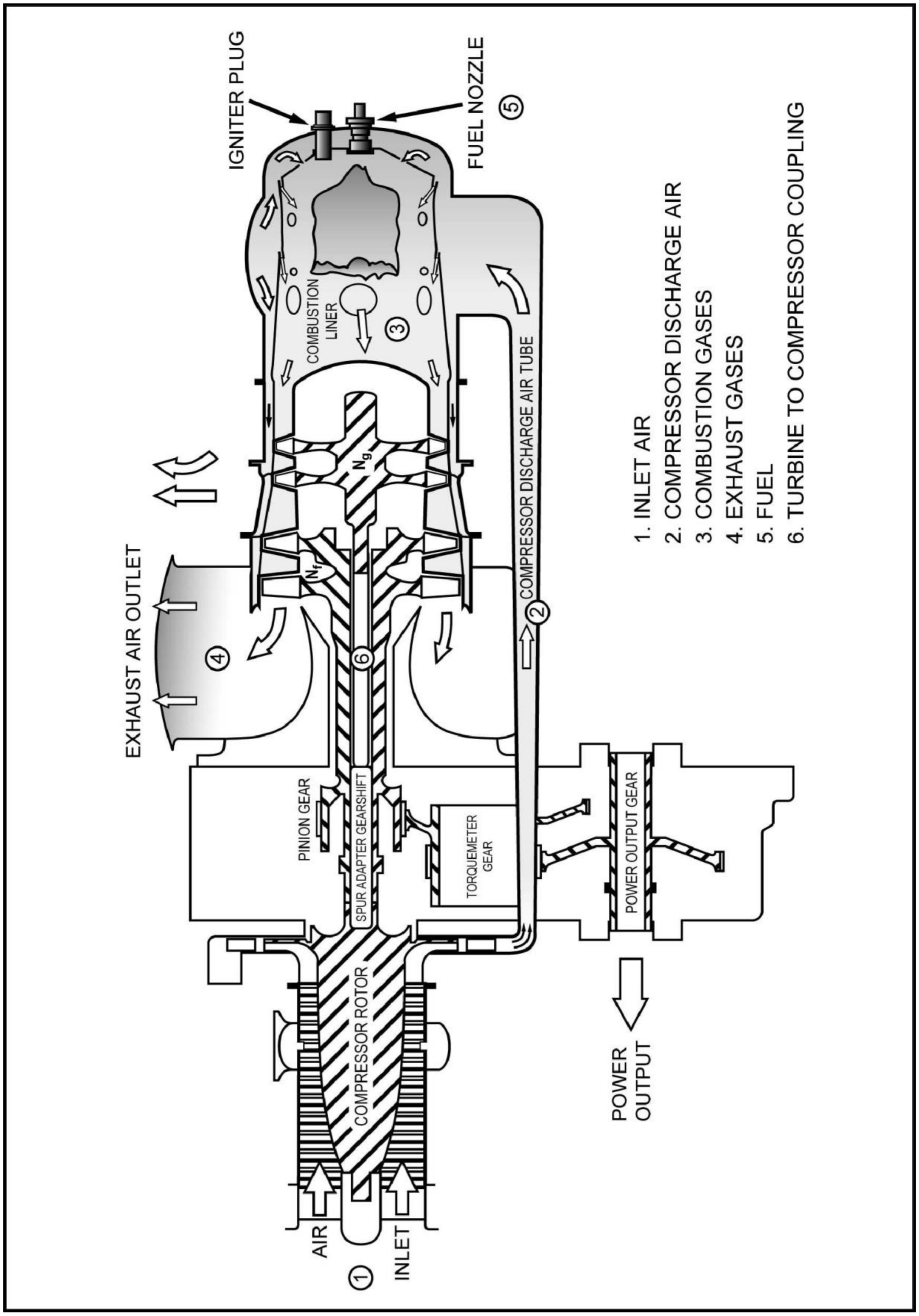

Figure 2-6 Air Flow Schematic

205. TURBINE SECTION

The turbine section converts heat energy to mechanical energy. It is comprised of a two-stage gas producer (referred to as the N_g or N_1) turbine and a two-stage free power (referred to as the N_f or N_2) turbine.

Expanding gases from the combustion section first enter the gas producer turbine where about 2/3 of the energy is used to drive the compressor section and the gas producer drive train (Figure 2-7). Details of products of this drive train are provided in the next section of this chapter. Most of the remaining energy is used by the free power turbine to power the free power drive train (Figure 2-8). Exact functions are discussed later in this chapter. The remaining gases with very little heat energy left are collected in the exhaust collector. The exhaust gases are discharged from the exhaust collector through the twin stacks into the atmosphere.

Temperature measuring of the engine is accomplished with the use of an equal resistance branch thermocouple harness assembly with four integral probes. These probes sense the temperature of the gases on the outlet side of the gas producer turbine. A DC voltage, which is directly proportional to the gas temperature it senses, is generated by each thermocouple. The thermocouples and thermocouple harness provide an average of the four voltages representative of the TOT for cockpit temperature indication (Figure 2-9). Even though the thermocouples are "self generating", 28V DC power is needed to operate the cockpit gauge.

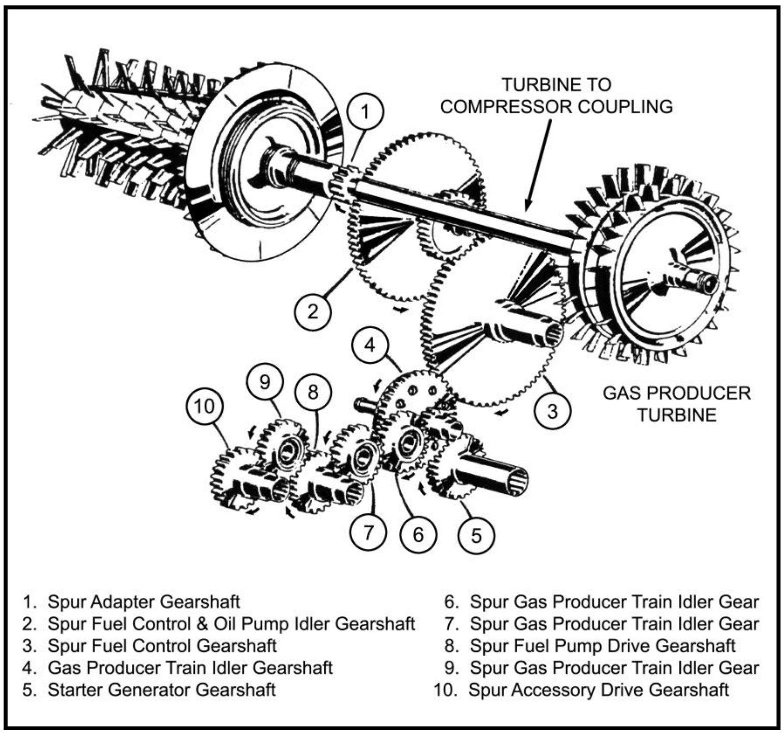

Figure 2-7 Gas Producer Gear Train

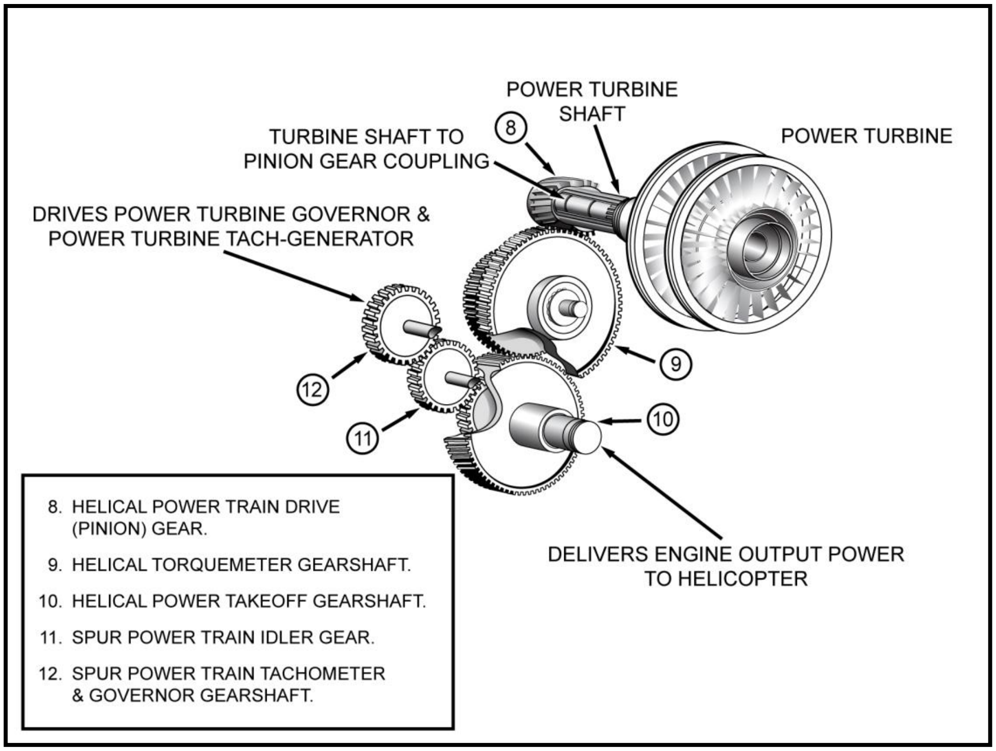

Figure 2-8 Power Turbine Gear Train

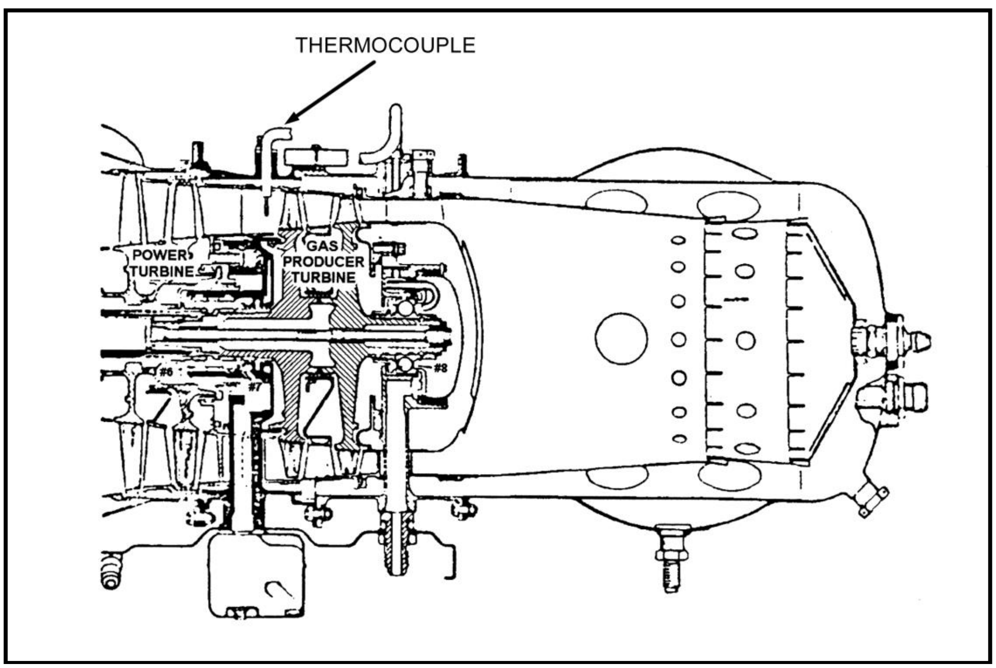

Figure 2-9 Thermocouple Location

206. ACCESSORY GEARBOX

The last major section of the 250-C20J engine is the accessory gearbox. The accessory gearbox is the primary structural member for the engine as it provides mounting and support for the compressor and turbine assemblies. The accessory gearbox has four engine mounting pads, but only uses three for mounting. ***The top pad is used to mount the anti-icing motor.*** The accessory gearbox contains most of the lubrication system components and incorporates two separate gear trains (Figures 2-10 and 2-11).

The gear train used with the gas-producer section powers accessories to start and run the engine. The accessories driven by the gas-producer include:

S - Starter-Generator

T - Tachometer-generator (N_g)

O - Oil Pump

F - Fuel Control

F - Fuel Pump

S - Standby Generator (C)

A convenient method to commit these to memory is by the abbreviation ***STOFF***. The TH-57C has one additional unit and that is the ***standby generator*** making the abbreviation ***STOFFS.*** The other gear train is driven by the free-power turbine. The free-power for the TH-57 drives four units which can be remembered by the abbreviation ***GOTT***:

G - Governor (N_f)

O - Output Shaft (Power)

T - Tachometer-Generator (N_f)

T - Torquemeter

The torquemeter assembly is located in the accessory gearbox and measures the output torque of the engine. As torque is developed, the helical gear in the free power turbine gear train will provide a proportional oil pressure through an oil line to a transducer. The transducer converts the oil pressure to an electrical voltage for the D.C. powered torque gauge. The power output gear is where the power turbine energy is transmitted to the freewheeling unit to drive the rotor system. The freewheeling unit will allow the rotor system to rotate without driving the engine in the event of a power loss.

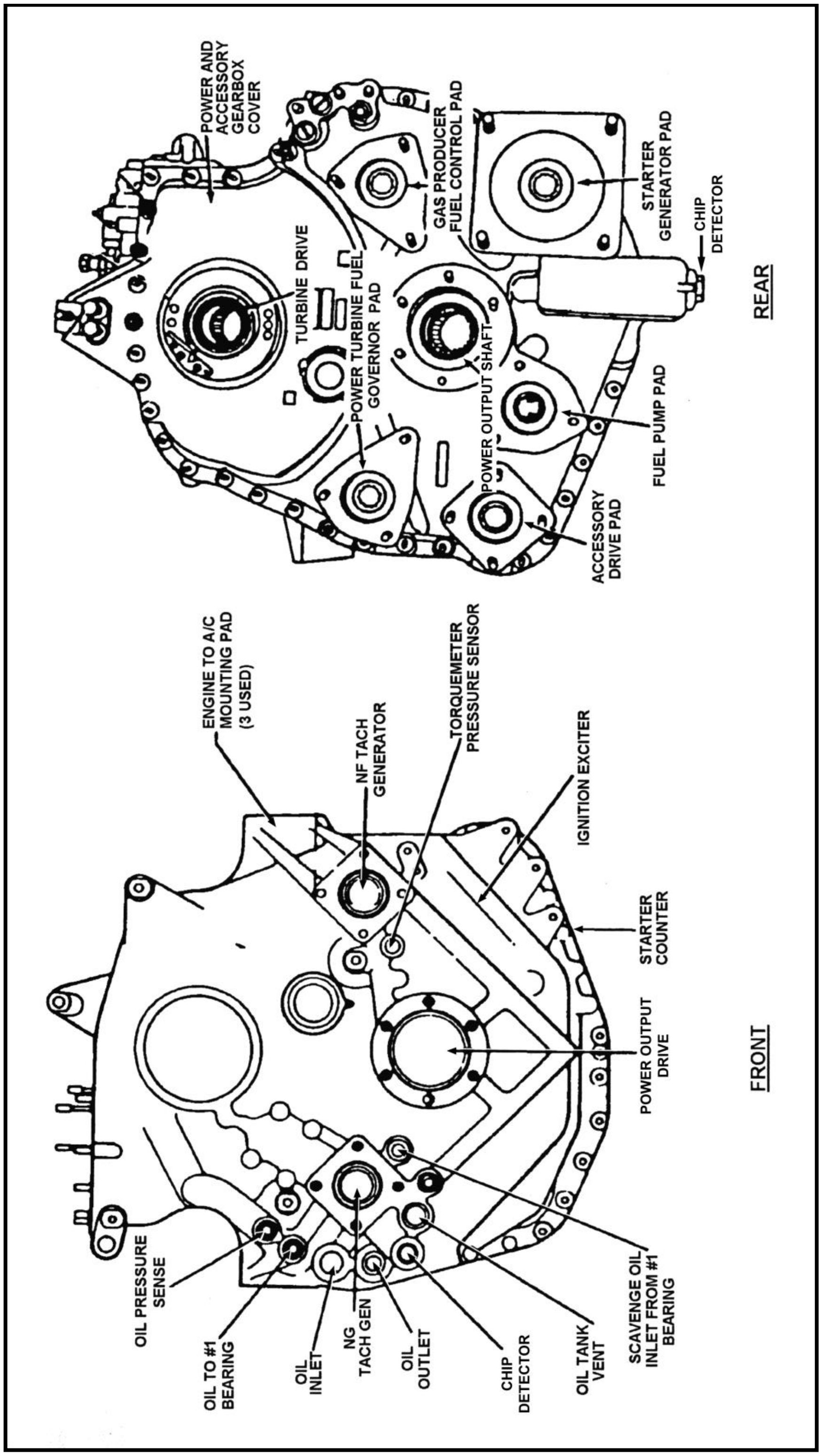

Figure 2-10 Accessory Gearbox Mounting Pad Locations

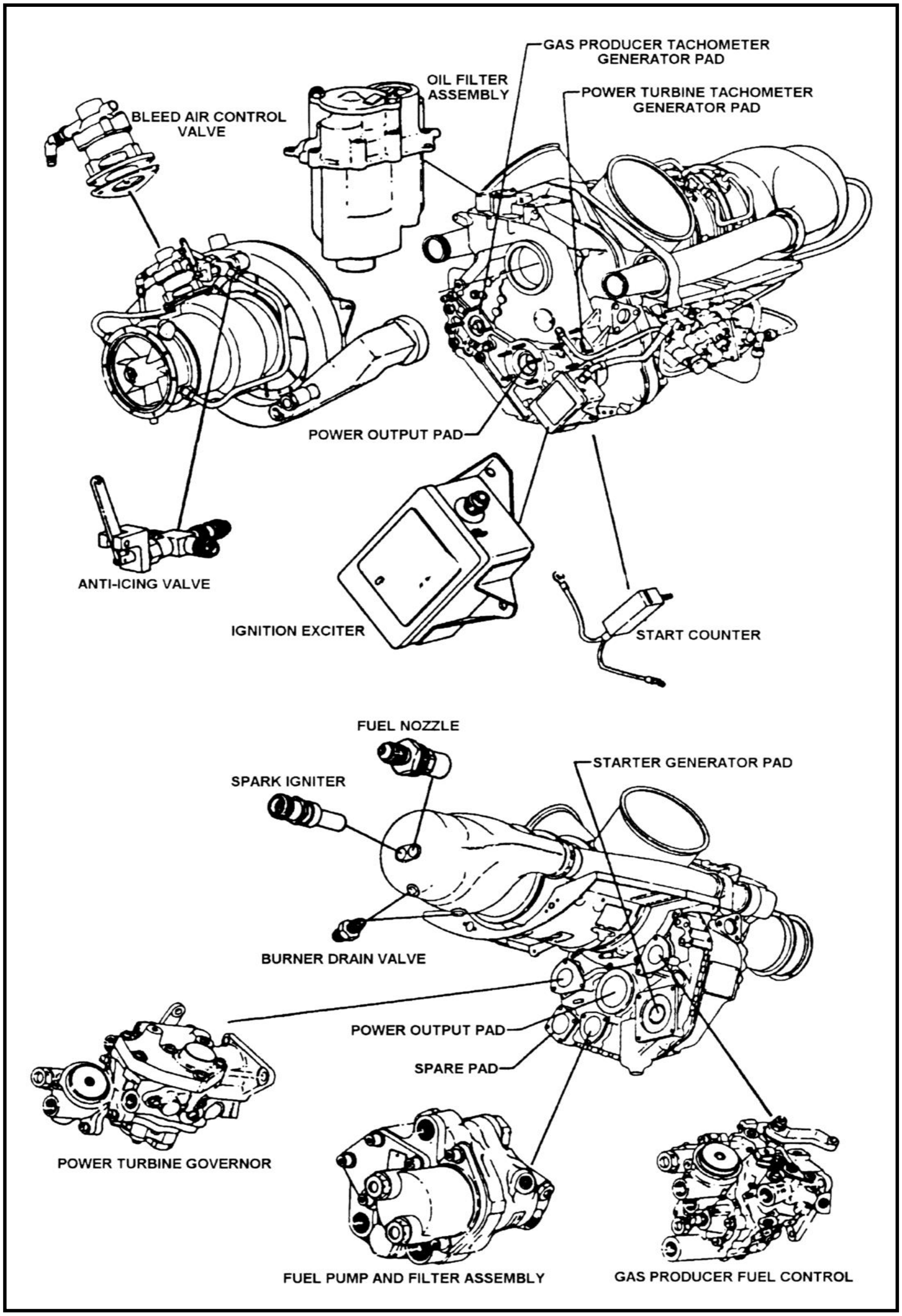

Figure 2-11 Accessories Location

Several ancillary systems support and ensure safe operation of the 250-C20J engine. These include:

1. Oil system

2. Chip warning system

3. Anti-ice system

4. Fire detection system

5. Engine failure warning system

6. Rotor revolutions per minute (RPM) warning system

207. ENGINE OIL SYSTEM

A ***pressurized circulating dry sum-type oil system*** is used to oil and cool engine bearings. The oil tank, cooler, and filter are mounted on the airframe. Now let's discuss the flow of the oil and the location of the components in the oil system (Figures 2-12 and 2-13). The components included in this discussion are:

1. Reservoir

2. Oil Pump

3. Internal filter

4. External filter

5. Oil cooler

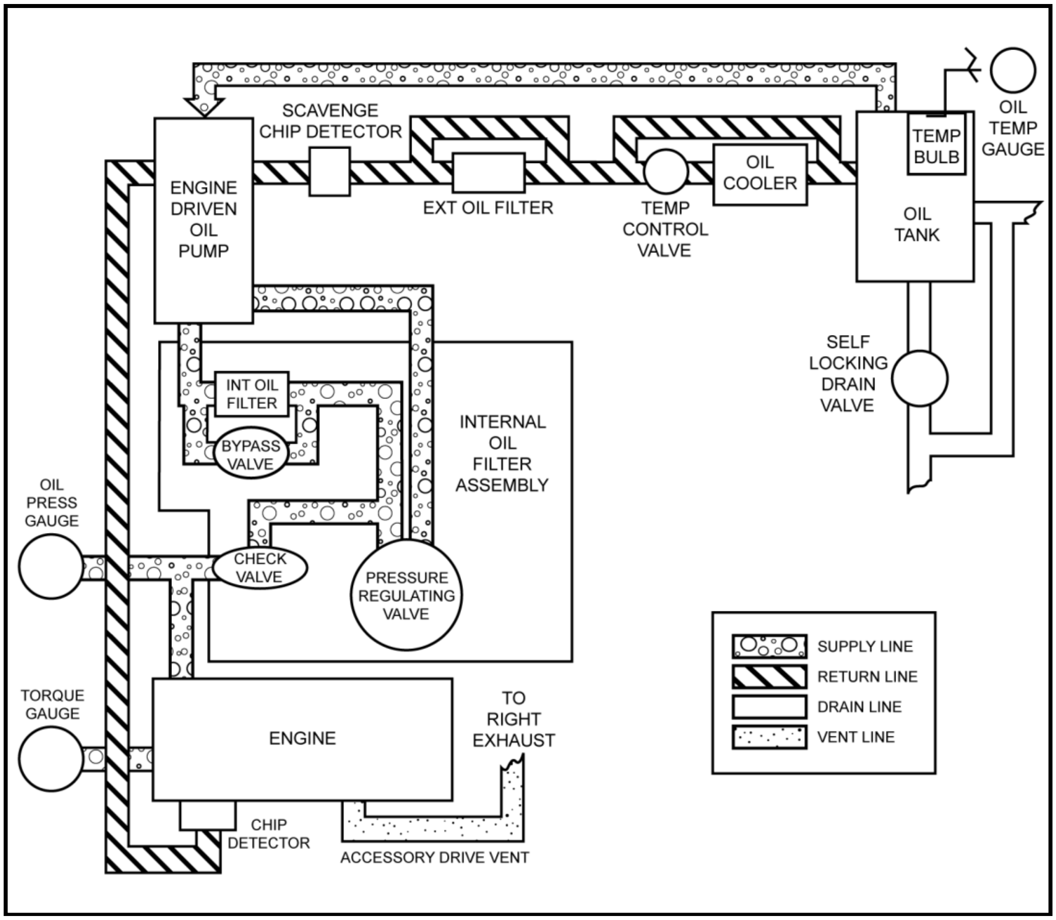

Figure 2-12 Engine Oil System

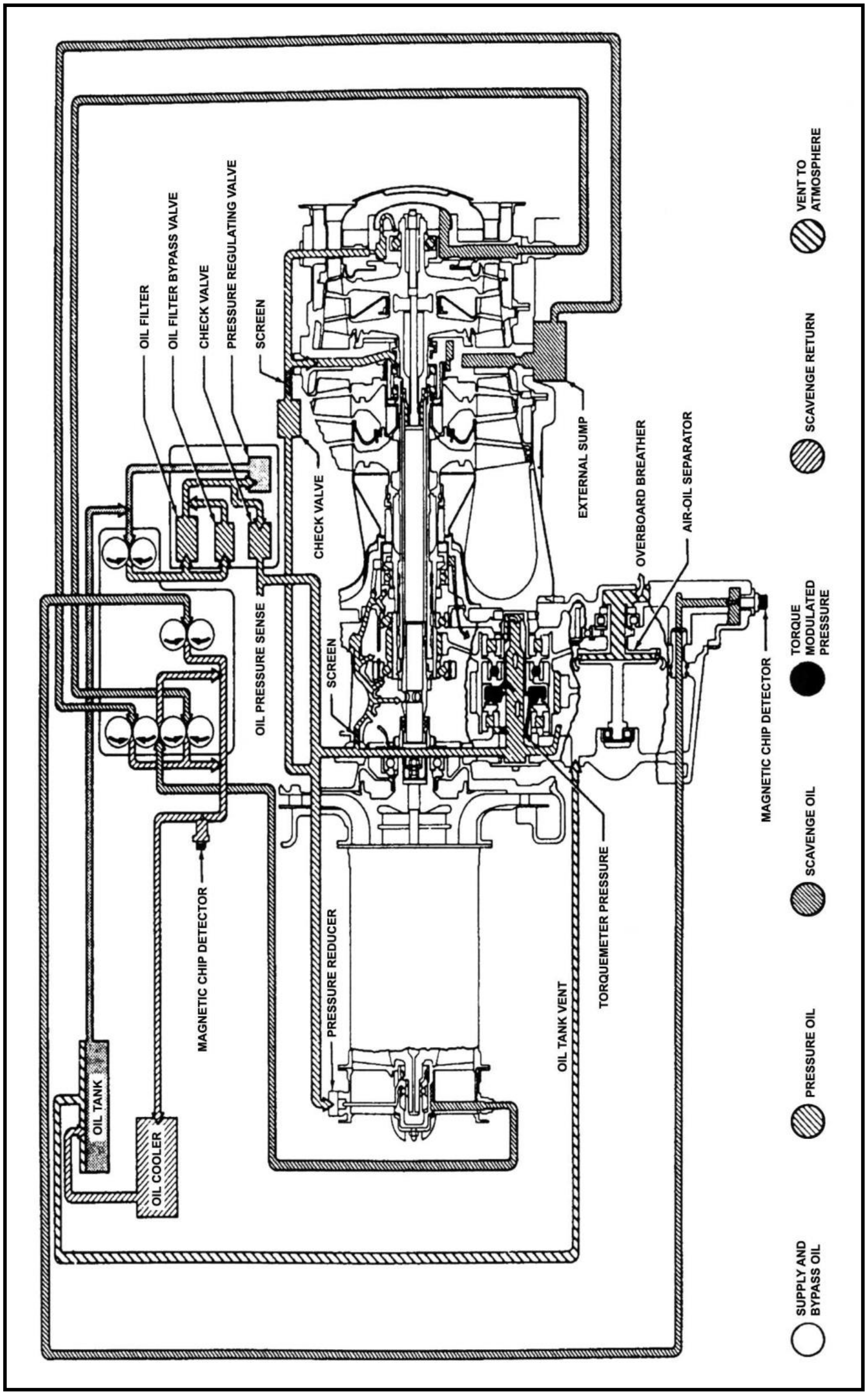

Figure 2-13 Typical Lubrication System Schematic

208. OIL TANK RESERVOIR

The oil tank reservoir is mounted over the tall rotor drive shaft on the aft deck at fuselage station 167.0 (Figure 2-14). The oil tank reservoir has a capacity of 5.5 quarts and contains openings for the supply and return lines, oil level sight gauge, oil temperature bulb, vent, self-locking drain valve, and filler cap. There are two methods of checking the oil level: ***One method is by a sight gauge on the port (left) side of the reservoir, the second method and the only way to determine the exact oil level is to check it with the dipstick which is mounted in the filler cap.*** The filler cap is accessible through an access panel located on the starboard (right) side of the aircraft. The sight gauge will indicate the oil level is up to the sight gauge. To help us understand the importance of knowing the exact oil level, we will discuss the freewheeling unit oil system. A complete discussion o the freewheeling unit is included in a later chapter. The freewheeling unit mounts to the engine at the power output gear. The freewheeling unit is pressure lubricated by the transmission oil system. Since the freewheeling unit is mounted at the power output gear, the two oil systems are only separated by oil seals. ***A failure of a seal will allow transmission oil to enter the engine oil system and cause an overfull condition.*** The only indication of a seal failure will be the overfull reading on the dipstick. Remember, the sight gauge indicates the oil level is at the gauge, but will not indicate if it is above the gauge.

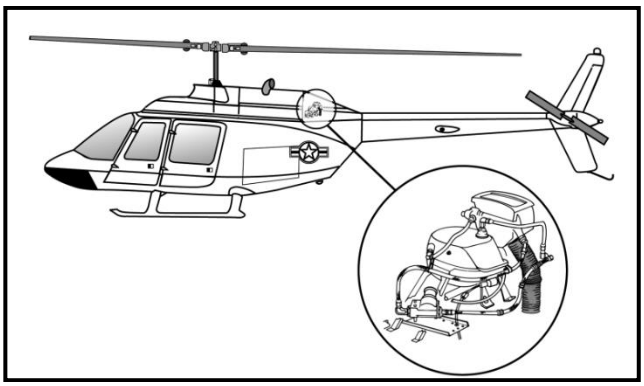

Figure 2-14 Engine Oil Reservoir Location

Oil is delivered to the ***engine oil pump located in the accessory gearbox. The oil pump is a gear type*** consisting of one pressure element and four scavenge elements. ***The pump assembly is driven by the N_g gear train***, which allows the pump to work in proportion to the speed of the N_g section. With higher N_g speed, more oil is pumped to keep the lubrication at the higher level needed by the increased engine loads. The pressure element of the pump delivers oil under pressure to the inlet port of the internal oil filter. The internal oil filter assembly mounts inside the accessory gearbox near the top engine mount pad (Figure 2-15). The internal oil filter housing contains a pressure regulating valve, filter element, and differential pressure bypass valve. The filtered oil is delivered through a one-way check valve to the gearbox housing passage, and the oil pressure sensing port. From that point, the oil flows throughout the engine. After the oil is delivered to the engine components, it will drain into the sump areas. From the sump areas, the hot engine oil is picked up by the scavenge elements of the oil pump and delivered aft to the external oil filter and oil cooler.

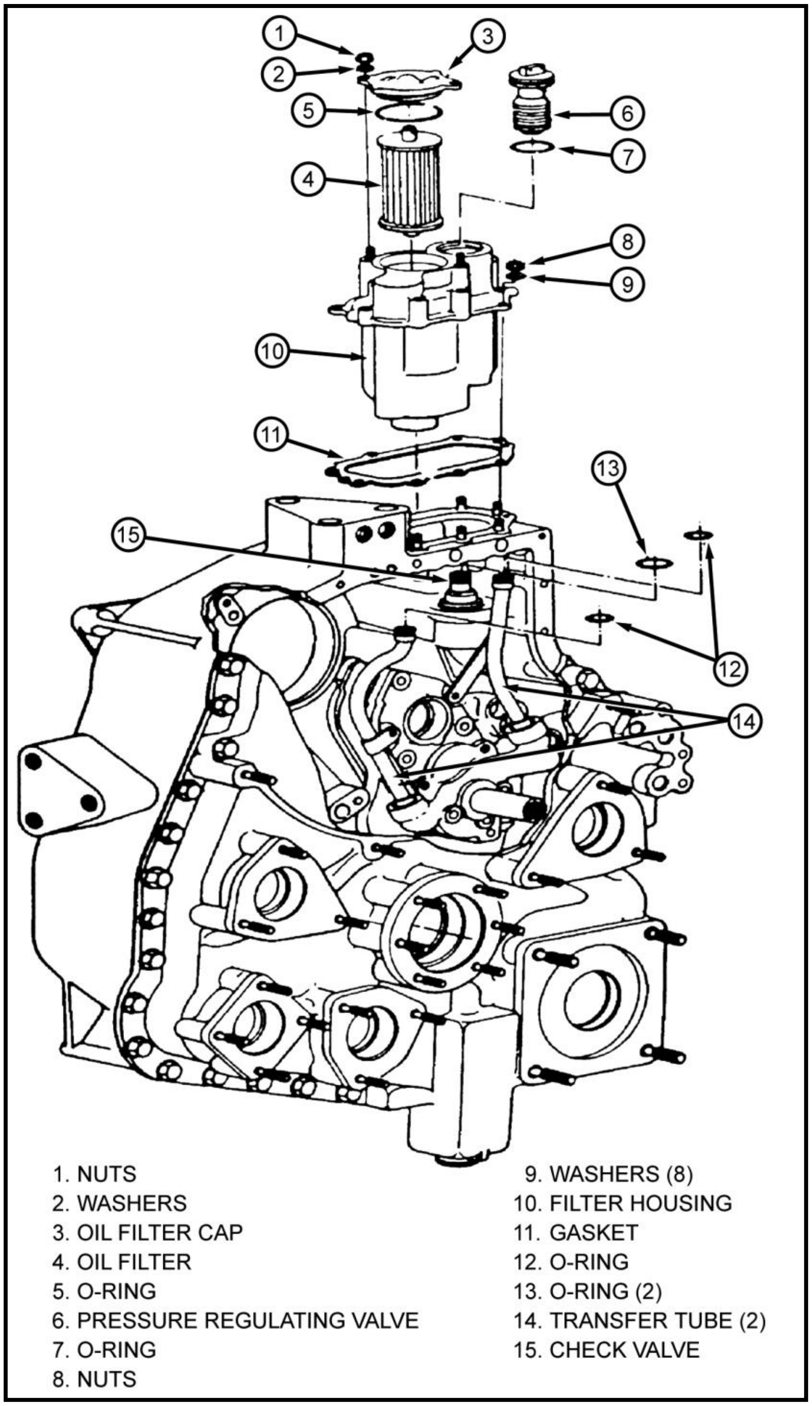

Figure 2-15 Oil Filter, Filter Housing, and Pressure Regulating Valve

The external or airframe filter is located beneath the aft engine fairing near the engine oil tank. The filter assembly consists of a filter element, body and head (Figure 2-16). The filter head has a bypass provision and a red button that indicates an impending bypass. ***In the event the filter becomes clogged, the bypass will allow the oil to return to the oil tank. When the oil bypasses, the pressure will pop the red indicator button out.*** The filter can be viewed through the inspection door near the left side of the oil tank. ***A disposable filter element is installed in the filter body.*** The 10-micron rated filter will remove impurities such as carbon and ferrous particles. After the hot engine oil has been filtered, it is routed to a **radiator type oil cooler** (Figure 2-16) located near the oil tank. ***Oil flow through the oil cooler is regulated by a temperature control valve.*** Cold oil is directed back to the oil tank without entering the cooling section. When oil temperature reaches approximately ***160° Fahrenheit (71°C.)***, the valve starts to open. As the hot oil flows through the radiator type cooler, cooling air is forced through the cooler, removing heat from the oil**.** ***Cooling air is provided by a squirrel cage type fan, which is driven by the tail rotor drive shaft system (Figure 2-17). The oil cooler fan also provides cooling air for the transmission oil and the hydraulic reservoir.***

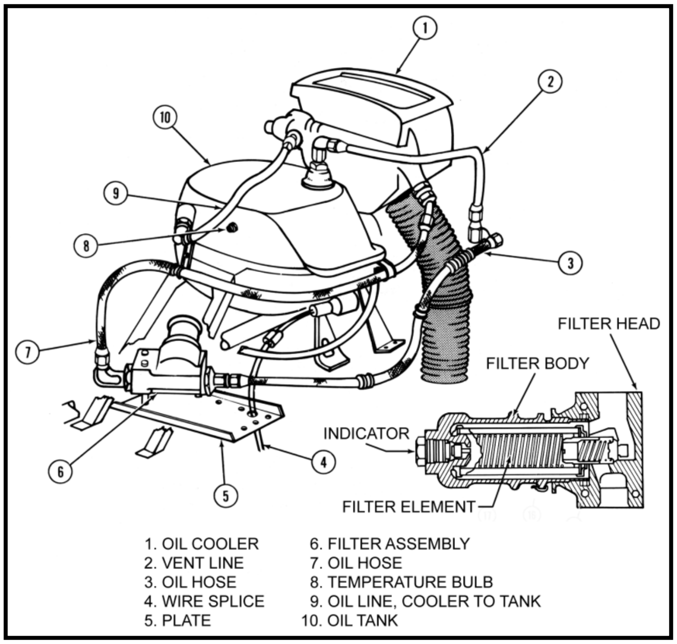

Figure 2-16 Engine Oil System

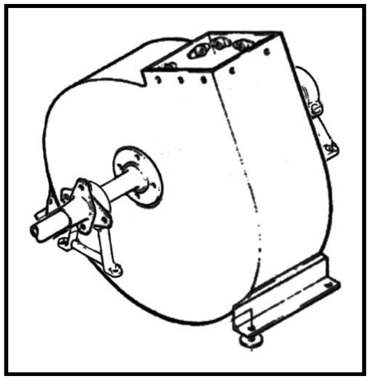

Figure 2-17 Oil Cooler Fan

209. ENGINE OIL SYSTEM MONITORS

Engine oil is monitored for temperature, pressure, and metal particles. Temperature and pressure readings are monitored by a dual gauge, located on the instrument panel. ***Two magnetic chip detectors monitor the oil for metal particles. A temperature bulb, located in the engine oil tank, sends electrical signals to the oil temperature gauge in the cockpit.*** Oil pressure is indicated on the pressure side of the dual (temperature/pressure) gauge. A pressure-sensing port is mounted in the oil system downstream of the internal filter. Piping from the sensing port connects directly with the pressure gauge. Since oil is sent to the pressure gauge for a reading, this system is called a wet-line system. The two magnetic chip detectors monitor internal wear and give an indication of possible internal failure (Figure 2-10).

The chip detectors are mounted in the accessory gearbox and are electrically connected to the engine chip caution light. The chip detectors have a magnetic center point that attracts ferrous particles of metal. When enough particles have accumulated on the magnetic plug to complete an electrical circuit, the engine chip light will illuminate. Ferrous particle accumulation could indicate impending failure of engine parts.

The chip detectors are of the pulsed electrical (zapper) type, incorporating an electromechanical system that uses stored electrical energy to distinguish between non-critical "normal" debris and more significant failure indicating contaminant. When an engine chip light illuminates, a manual "burn-off" can be attempted by depressing momentarily and releasing the indicator type switch on the instrument panel labeled "clear chip." The 28-volt circuit, that supplies power to the light, charges the pulsing network which is in parallel with the open chip gap. If the debris on the chip gap was of a nuisance variety (fuzz) it will be pulsed (zapped) away and the engine chip light will turn off. If the debris is large and cannot be pulsed away, the light will remain on. Frequent chip lights successfully extinguished by the "clear chip" indicator switch may be considered significant.

210. ANTI-ICE SYSTEM

Operation of the engine during icing conditions could result in ice formation on the compressor front support. To prevent this condition the engine is equipped with an engine anti-icing system. Operation of this system must be selected by the pilot. The anti-icing system includes an anti-icing valve mounted at the 12 o'clock position on the front face of the diffuser scroll, which allows bleed air to flow through two stainless steel lines between the anti-icing valve and the compressor front support and passages within the compressor front support. The front support has seven radial struts that are hollow to allow passage of hot air for anti-icing. Installed on the top engine mount is an electric motorized gear driven lever with an adjustable push-pull tube coupled to the gear driven lever and anti-ice valve for operation of the anti-ice valve (Figure 2-18).

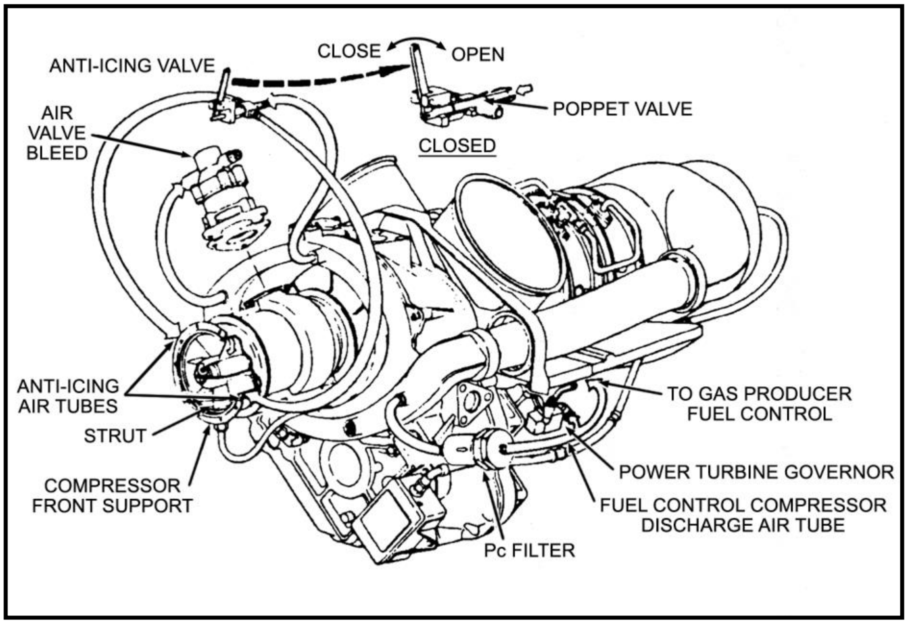

Figure 2-18 Anti-Ice System

211. ENGINE FIRE DETECTOR SYSTEM

A pneumatic principle engine fire detection system will activate the red ENG FIRE warning light on the caution panel if excessive heat is sensed in the engine compartment. Excessive heat in the engine compartment causes gas expansion in a sensing tube, located on the interior engine cowling, tripping a pressure switch which activates the engine fire warning light. Depressing the FIRE DET TEST button should illuminate the light; indicating proper functioning of the bulb, electrical circuitry, and integrity of the sensing element.

212. ENGINE FAILURE WARNING SYSTEM

An engine RPM sensor, forward of the instrument panel and connected to the Ng tachometer generator, causes the engine-out audio unit to emit a beeping signal and activate the red ENG OUT warning light when N_g drops below 55 $\pm$ 3 percent. An audio mute switch, located on the left side of the caution panel, provides the pilot with a means of silencing the headset warning horn for ENG OUT (and ROTOR LOW RPM). The cabin warning horns will remain functional.

A low rotor RPM sensor switch, splined to the N_r tachometer-generator drive shaft, causes the low rotor RPM audio unit to emit a steady audible tone and activates the ROTOR LOW RPM caution light when N_r drops below 90 $\pm$ 3 percent. A sensing switch on the collective disables the audio unit when the collective is within approximately 1 inch of the full down position.

213. ENGINE CONTROLS

The fuel control system consists of the gas producer (N_g), fuel control unit, and the free power turbine (N_f) governor. It is a pneumatic mechanical type system, which provides correct fuel metering, automatically compensating for ambient air pressure and temperature changes associated with altitude changes.

In a turboshaft engine the fuel control unit (Figure 2-19) meters fuel flow. If fuel metering is incorrect for the velocity and pressure of the air through the engine, the following problems can occur: Excessive temperature, compressor stall, compressor surge, and rich or lean blowout.

As you should recall from earlier in this chapter, the N_g and N_f turbines are not mechanically connected. This type of design has a slow response time in transferring power from the N_g to the N_f turbines. Due to this slow response, a hand throttle is impractical for control. Therefore, the fuel control system also incorporates an N_f governor (Figure 2-19), which works in conjunction with the fuel control unit.

Some of the factors involved in regulating the fuel flow are: Twist grip position, compressor discharge air pressure, N_g speed, and N_f speed.

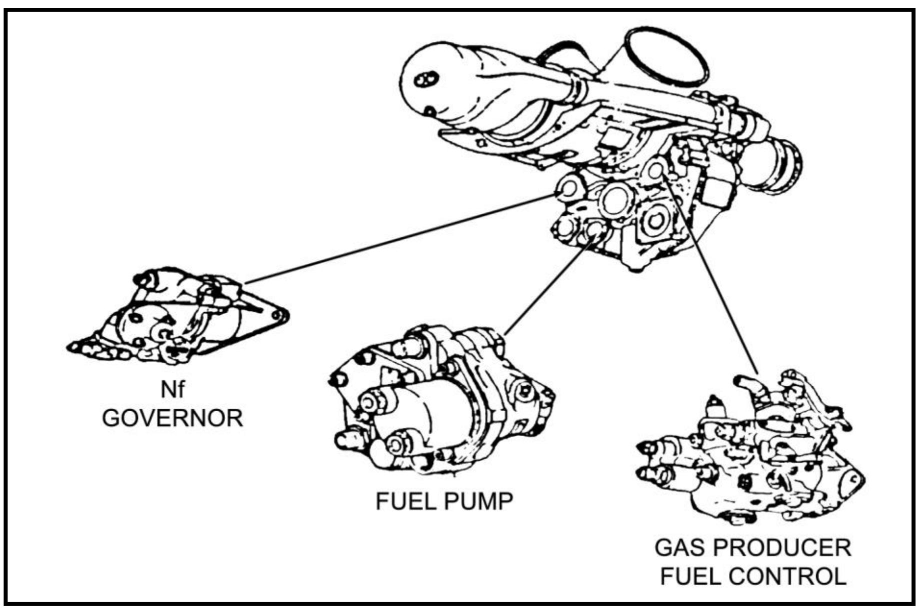

Figure 2-19 Fuel Control

A rotating twist grip (Figures 2-20 and 2-21) is located on each collective and is connected to the fuel control throttle lever through control rods and cables. The twist grip has three normal operating positions: off, flight idle, and full open. In the off position a cutoff valve prevents fuel flow from the fuel control to the fuel nozzle. In the flight idle position fuel is metered for starting in response to compressor discharge air pressure. Idle RPM is stabilized; through the control of air pressure within the fuel control unit, by a flyweight assembly, driven by the N_g gear train, which senses N_g speed.

The N_f governor has little or no effect on the system until the twist grip is rotated to the full open position. In the full open position, the fuel control unit is capable of reacting to signals from the N_f governor, which are transmitted via air pressure lines. (Note: decreasing the twist grip from the full open position will prevent the governor from affecting the fuel control unit.) The N_f governor varies the air pressure signals to the fuel control unit through the operation of its internal flyweights, which are driven by the N_f gear train. Any deviation from the preset free power turbine RPM (100% N_f) will cause the N_f flyweights to change the air pressure signal to the fuel control. The air pressure inputs from the N_f governor, along with feedback from the fuel control internal flyweights (N_g-driven) work to adjust the fuel flow. The fuel control system controls engine power output (N_f) by controlling N_g speed with fuel flow.

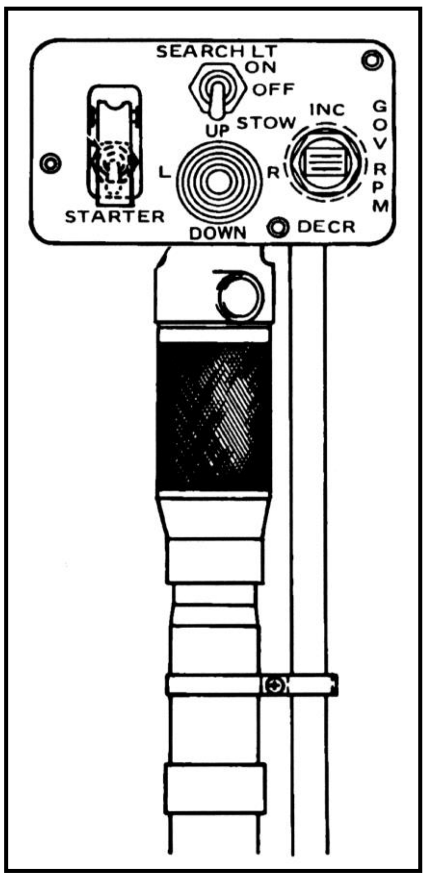

Figure 2-20 Pilot's Collective

N_f RPM is set by the pilot using the RPM increase-decrease switch; located on the Pilot's (right) collective (Figure 2-20). The RPM increase-decrease switch operates an electric motor called a linear actuator; which makes fine adjustments to the governor throttle lever (Figure 2-21). The RPM is set at 100% N_f and no further adjustment is usually required. The N_f governor throttle lever is also connected by mechanical linkage to the collective pitch control system. Movement of the collective by the pilot results in a corresponding movement of the N_f governor throttle lever. This minimizes transient N_f/N_r RPM variations as collective pitch changes are made by changing the air pressure signal to the fuel control in anticipation of the change in engine load. This "droop compensating system" is required, since N_f would droop or lag before the gas producer could compensate for a change in load.

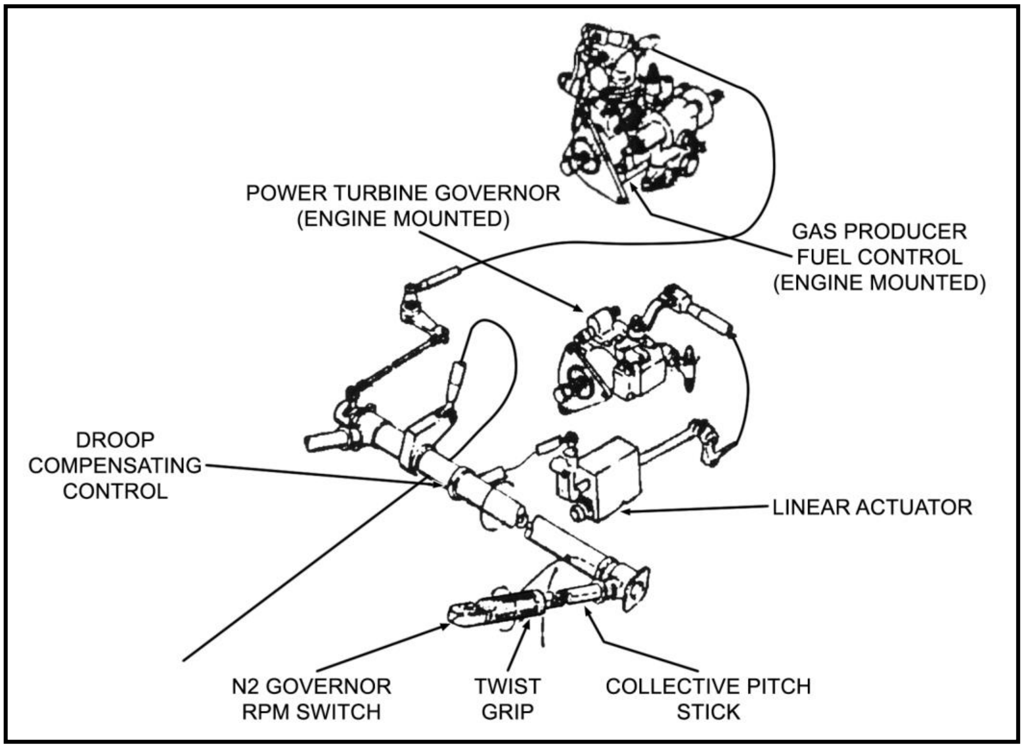

Figure 2-21 Droop Compensating and Engine Fuel Controls

214. TORQUEMETER

The torque gauge, located on the instrument panel, provides percent readings of the torque imposed on the engine output shaft. A helical gear in the free power turbine gear train senses changes in load and provides a proportional engine oil pressure through and oil line to a transducer. The transducer converts the oil pressure to an electrical voltage to the D.C. powered torque gauge.

215. TURBINE OUTLET TEMPERATURE INDICATOR

The TOT gauge receives indications from four sets of bayonet-type thermocouples mounted on the engine turbine section. The TOT gauge receives power from the DC common BUS on the TH-57B and from the essential #2 BUS on the TH-57C.

216. GAS PRODUCER TACHOMETER

The gas-producer turbine (N_g) tachometer shows percent RPM of the gas producer turbine. It is powered by the gas producer tachometer generator and no other electrical power is required.

217. DUAL TACHOMETER

Indicates both the power turbine and main rotor readings in percent. The needle marked **T** indicates power turbine RPM (N_f), and the needle market **R** indicates main rotor RPM (N_r). This instrument receives inputs from two tachometer generators. The generators are self-generating and are not connected to the electrical system.

218. ENGINE OIL AND PRESSURE GAUGE

Both engine oil temperature and pressure are shown on a dual gauge. The oil pressure gauge uses a wet-line system requiring no electrical power, and the oil temperature gauge is connected to an electrical resistance-type bulb located in the engine oil tank.

This concludes the discussion of the Rolls-Royce 250-C20J turboshaft engine.

CHAPTER TWO REVIEW QUESTIONS

1. The 250-C20J engine is limited to _______ horsepower due to torque limitations on the transmission.

2. Name the four subassemblies of the engine.

3. The compressor is divided into four subassemblies.

   a. True   b. False

4. Hot air is supplied to the _______ ________ ________ to prevent engine icing.

5. Anti-icing, hot air is supplied by the compressor bleed air valve.

   a. True   b. False

6. What is the main purpose of the compressor bleed air system?

7. How many stages of axial and centrifugal compression are used in the 250-C20J engine?

8. The type of combustor used in the 250-C20J engine is a __________.

9. Approximately _____ of the air flowing through the engine is used for cooling.

10. What is the purpose of the turbine section in the turboshaft engine?

11. Approximately ______ of the available energy in the turbine section is used to drive the compressor section and the gas producer drive train.

12. There is no mechanical connection between the free power turbine and the gas producer turbine.

    a. True   b. False

13. Thermocouples measure TOT. Where are they located?

14. The accessory gearbox is the primary structural member of the engine.

    a. True   b. False

15. The __________ __________ is mounted on the top mounting pad on the accessory gearbox.

16. Name the five accessories driven by the gas producer.

17. Name the four units driven by the power turbine gear train.

18. What type of engine oil system is used in the 250-C20J engine?

19. How is the exact engine oil level determined?

20. State the type of engine oil pump used, and identify the gear train which drives it.

21. Once the external engine oil filter becomes clogged, oil flow is stopped.

    a. True b. False

22. An oil cooler fan provides cooling for __________, __________, and __________.

23. A ___________ type of fuel control system is used in the 250-C20J engine which prevents ________, ________, and ________.

24. The twist grip control on the collective stick is linked to the ________.

25. How is the power turbine (N_f) governor controlled?

26. The engine fire detector system senses infrared light in the engine compartment.

    a. True b. False

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CHAPTER TWO REVIEW ANSWERS

1. 317
2. Compressor…Accessory gearbox…Turbine…Combustion
3. A
4. Compressor front support
5. False
6. To prevent the compressor blades from stalling
7. 6 axial…1 centrifugal
8. Single can
9. 75
10. To convert heat energy to mechanical energy
11. 2/3
12. A
13. At the exit of the gas producer turbine
14. A
15. Anti-icing motor
16. Starter generator…Gas producer tach generator…Oil pump…Fuel control…Fuel pump
17. Power turbine governor…Power turbine tach generator…Torque meter…Power output shaft
18. A pressurized circulating dry sump
19. Check the dipstick mounted in the filler cap
20. Gear type…driven by the gas producer gear train
21. False
22. The engine oil…transmission oil…hydraulic reservoir

23. Pneumatic-mechanical…excessive temperature…compressor stall or surge…rich or lean blowout

24. Gas producer fuel control throttle

25. By a linear actuator and droop compensating system

26. False

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CHAPTER THREE
FUEL SYSTEM

300. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will understand the operation of the fuel system and be able to identify its major components and subcomponents along with their associated functions and limitations.

301. ENABLING OBJECTIVES

State the major components of the fuel system and their functions.

1. Identify the characteristics of the fuel cell.

2. Identify the method(s) used to refuel the fuel cell.

3. State how the boost pumps and their components work to supply fuel to the engine and information to the pilot.

4. Identify the various fuel pressure limitations and the associated operational restrictions.

5. Identify the various gauges, switches, etc., that relay pressure information, along with their limitations.

6. Identify the components and characteristics of the fuel quantity measuring system.

7. State how the pressure indicating system works to relay fuel pressure information to the pilot.

8. State how the shutoff valve works to permit or restrict fuel flow.

9. State the location of the airframe fuel filter and identify the functions of its components.

10. State the operational characteristics of the engine fuel pump/filter.

302. TH-57B/C FUEL SYSTEM

The TH-57 fuel system (Figure 3-1) consists of eight major components. ***These are the fuel cell, two fuel boost pumps, quantity measuring system, pressure indicating system, shutoff valve, airframe fuel filter, and engine fuel pump/filter.***

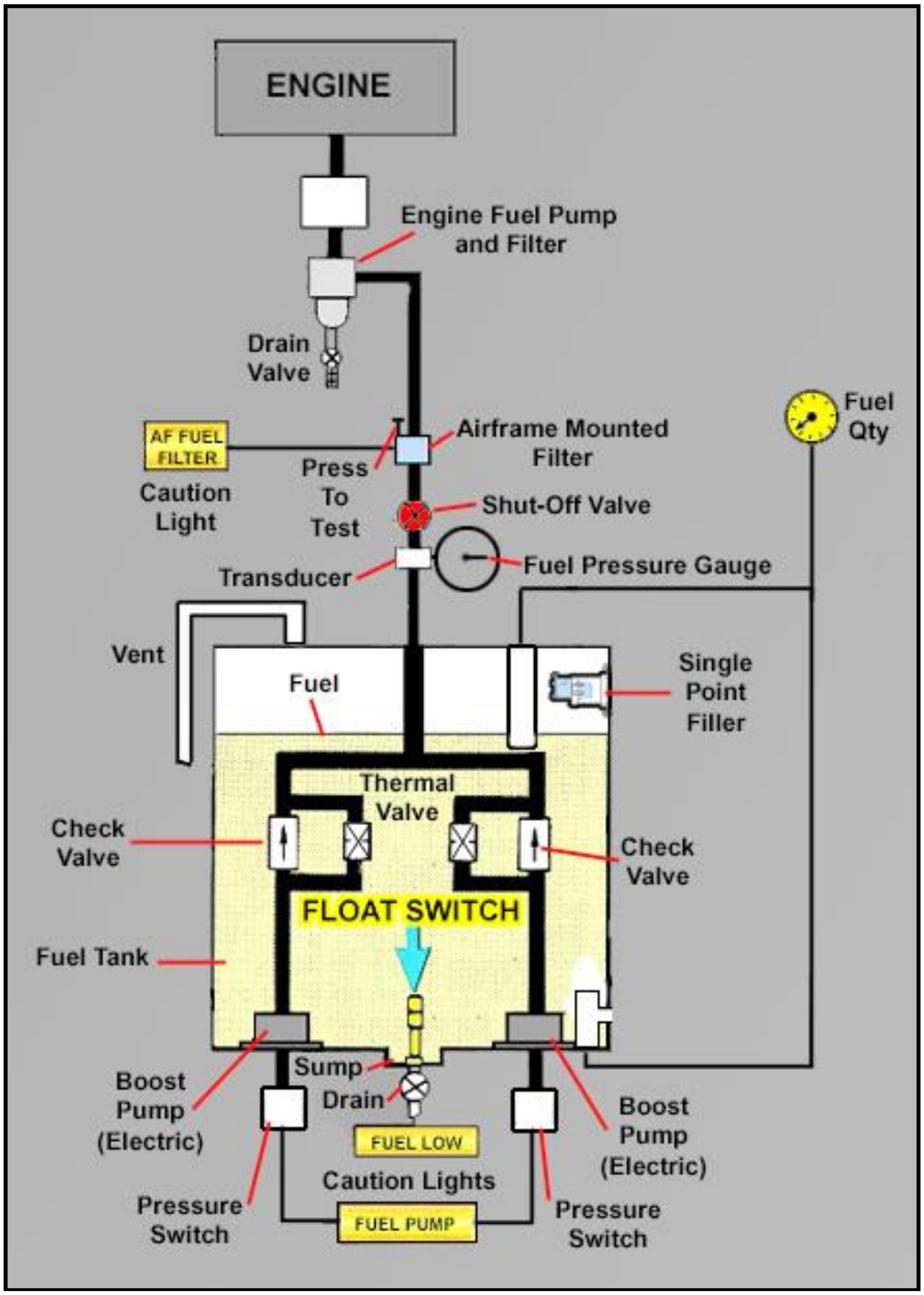

Figure 3-1 Fuel System Schematic

1. **Fuel Cell**

The largest component of the fuel system is the fuel cell (Figure 3-2). ***This single bladder-type fuel cell, located below and aft of the passenger seat, is crash-resistant, but not self-sealing. It has a capacity of 91 (76 in 161XXXB) gallons and is refilled from the starboard side, using a gravity-feed or pressure-feed system.***

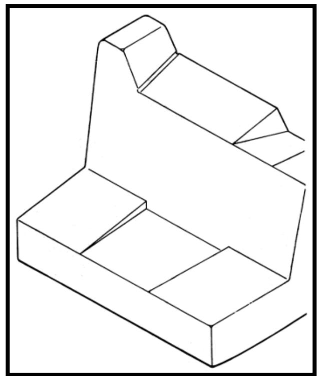

Figure 3-2 Fuel Cell

During pressure refueling, the closed circuit receiver (Figure 3-3) will automatically stop the fuel flow when the tank is full. Closed circuit refueling pressure is limited to a maximum of 40 psi (NATOPS limitation).

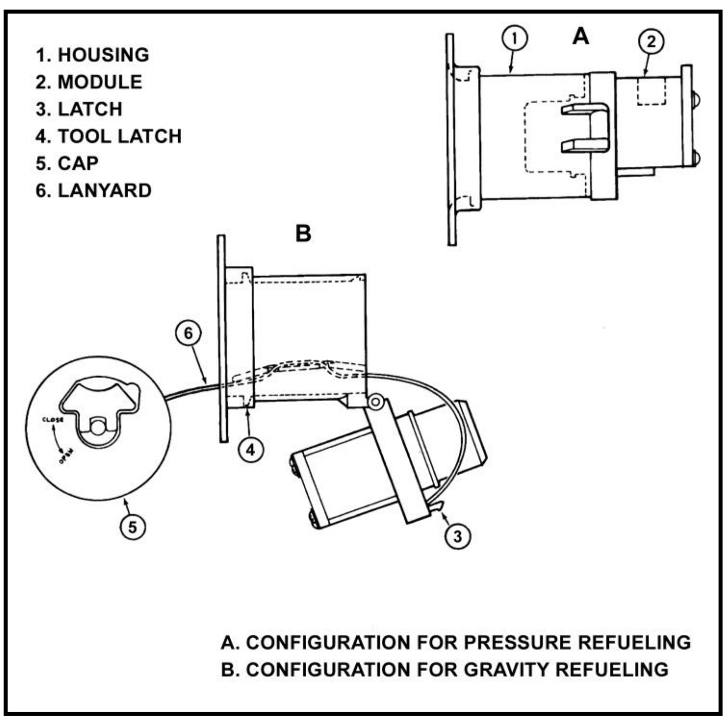

Figure 3-3 Closed Circuit Fuel Receiver

During gravity refueling, the inner module must be opened inward and refueling must stop when fuel becomes visible at the bottom of the receiver.

2. Fuel Boost Pumps

The two electrical boost pumps installed inside the fuel cell are shown in Figure 3-4. The pumps are interconnected by a hose so that they can furnish pressurized fuel through a single line to the engine-driven fuel pump. ***This pressurization prevents in-line vaporization above 6000 feet pressure altitude.***

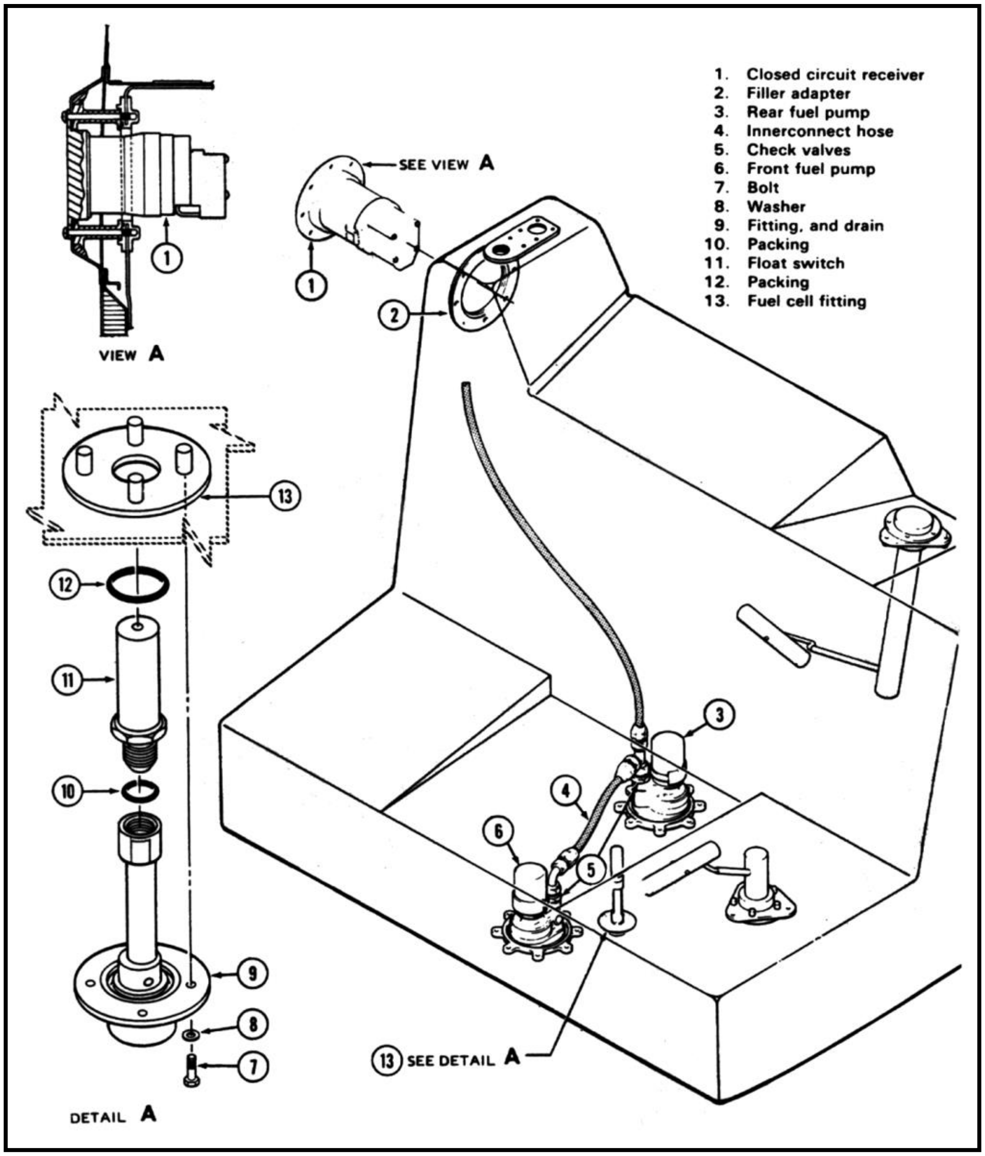

Figure 3-4 Fuel Boost Pumps

The boost pumps are energized any time the 28-volt DC BUS is energized and the circuit breakers are closed. The circuit breakers, one for each pump, are located on the overhead console. Each pump in Figure 3-5 is equipped with a check and thermal relief valve, intake screen, and pump pressure switch. ***The pressure switches, located in the pump discharge ports, are connected to a caution light labeled "FUEL PUMP" on the caution light panel. If discharge pressure drops below 3.5 psi, the caution light illuminates. To determine if one or both pumps have failed, check the fuel pressure gauge. A reading of 4 to 30 psi indicates that one pump is still working. A reading of zero indicates both pumps have failed. In this event, the engine-driven pump will draw fuel from the fuel cell. With either a single or dual boost pump failure, flight is restricted to below 6,000 feet pressure altitude.*** Normal flight operations require landing with no less than ten gallons. With one or both boost pumps inoperative landing is required with no less than 20 gallons to ensure the boost pump intake screen remains submerged and air does not enter the system. Furthermore, avoid maneuvers that would uncover the intake screen, because this will allow air to enter the system and a flameout could occur.

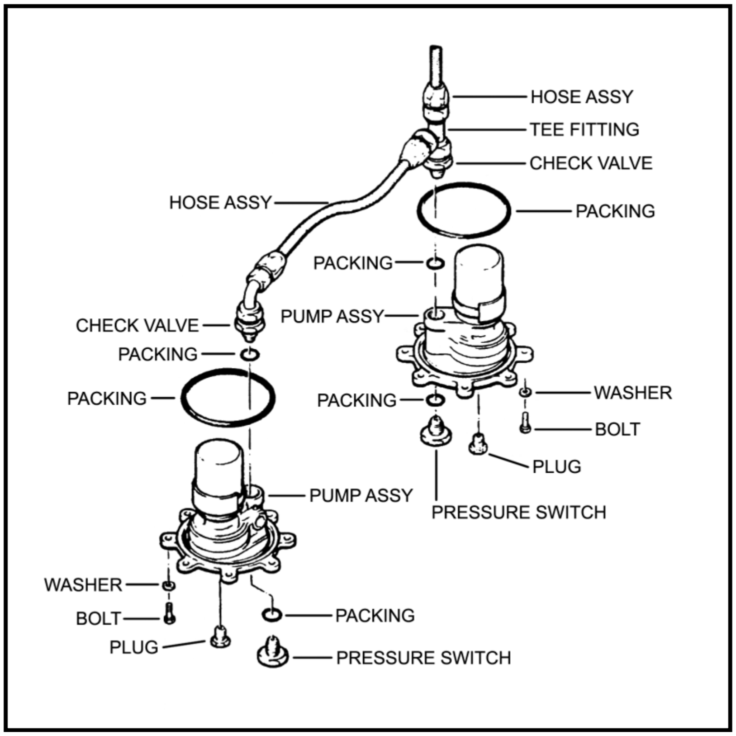

Figure 3-5 Boost Pump Schematic

3. **Quantity Measuring System**

The two float-type quantity indicating units (Figure 3-6) are located in the fuel cell. The lower unit mounted in the bottom of the cell monitors fuel level in the tank up to the bottom of the passenger seat, while the unit mounted in the top of the tank monitors fuel level in the upper section. ***Both units provide inputs to a single fuel quantity indicator*** (calibrated in gallons), which is located on the instrument panel. This indicator is powered by 28 volts DC and protected by a circuit breaker labeled "FUEL QUANTITY PRESS."

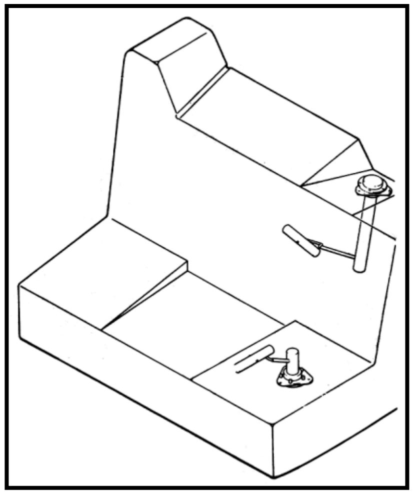

Figure 3-6 Upper and Lower Quantity Indicator Units

When fuel quantity is reduced to approximately 20 gallons, a fuel-low caution light illuminates. This light is activated by a simple float-type switch, located in the fuel cell atop the sump drain (Figure 3-7).

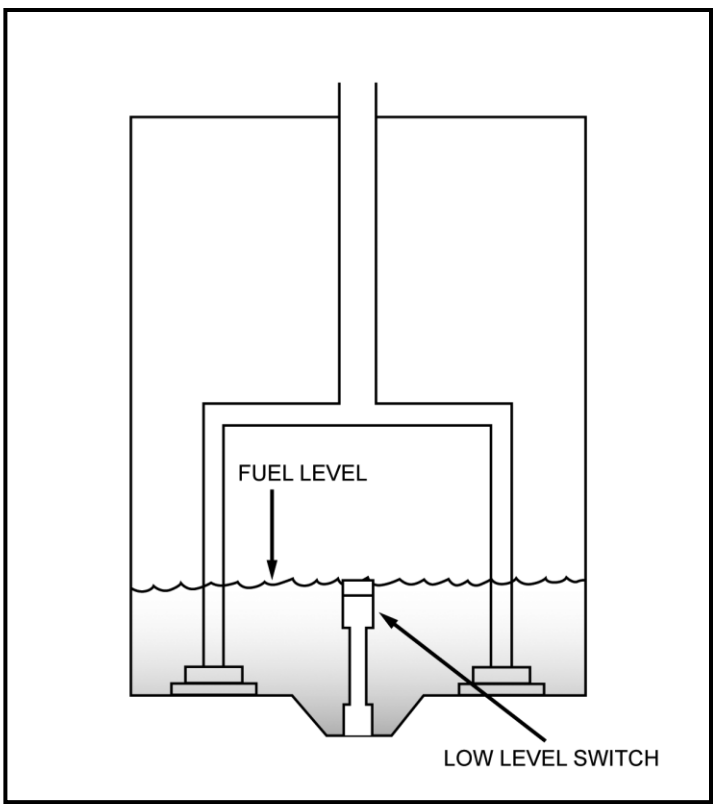

Figure 3-7 Fuel Low Level Switch

4. **Pressure Indicating System**

A fuel pressure transducer (Figure 3-8) is located in the fuel line between the boost pumps and the fuel shutoff valve. This transducer senses boost pump pressure and ***sends a signal to the fuel pressure gauge*** for visual presentation to the pilot. The fuel pressure gauge is a dual gauge, which reads direct current loads and fuel pressure. The gauge, located on the instrument console, operates off the 28-volt DC circuit and is protected by the fuel quantity-pressure circuit breaker.

5. **Shutoff Valve**

Figure 3-8 also shows the fuel shutoff valve. This motor-operated shutoff valve, incorporating a thermal relief feature, is installed in the main fuel supply line and is located in the fuel compartment above the filler cap. The valve is electronically controlled by an ON/OFF switch located on the instrument panel and protected by a circuit breaker located in the overhead console panel. With this switch in the ON position, fuel is supplied to the engine. ***In the event of electrical failure, the valve will remain in the last position selected before failure.***

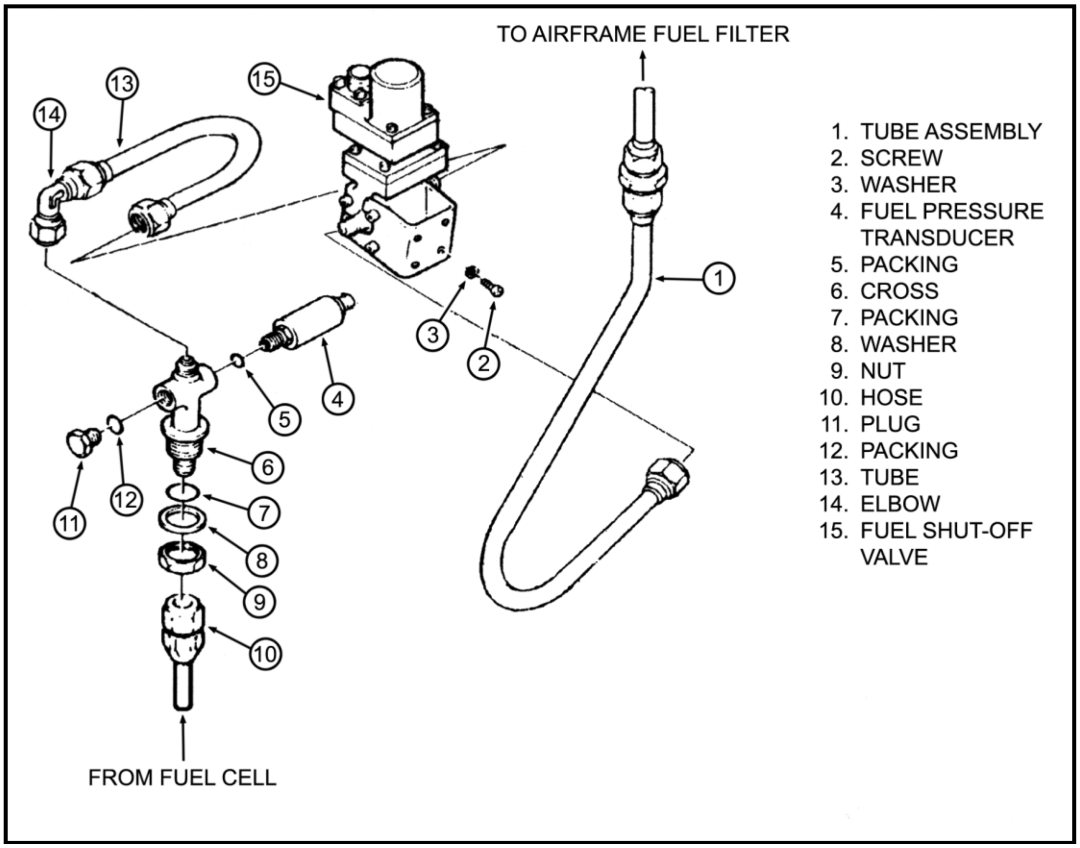

Figure 3-8 Fuel Shutoff Valve

303. AIRFRAME FILTER

From the fuel valve, fuel flows to the airframe filter mounted on the right side of the forward firewall. This assembly (Figure 3-9) filters inlet fuel to the engine and consists of a replaceable filter element, a drain valve, a bypass valve, impending bypass switch, and manual test button. The bypass switch monitors fuel pressure and causes the A/F FUEL FILTER caution light to illuminate if pressure drops below safe operating limits due to filter contamination. The manual test button is used to test the fuel filter caution light circuit. The purpose of the bypass valve is to allow fuel flow to the engine if the fuel filter becomes clogged.

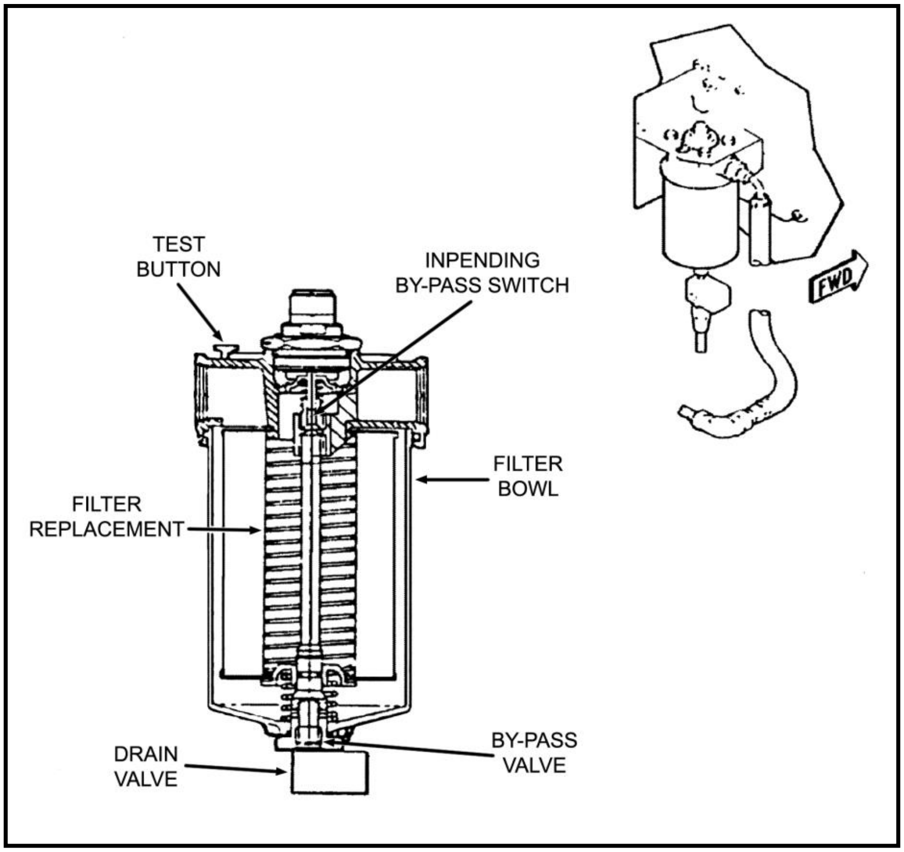

Figure 3-9 Airframe Fuel Filter

1. **Engine Fuel Pump/Filter**

Fuel pressurized by the boost pumps flows from the airframe filter to the engine fuel pump located on the aft port side of the engine accessory gearbox. Fuel enters at the inlet port of the pump and passes through a low pressure filter. ***This low pressure filter passes fuel at 4 to 30 psi to the gear element of the fuel pump. A bypass valve in the pump assembly allows fuel to bypass the low pressure filter element should it become clogged. The pump pressurizes fuel at 650-750 psi*** and passes it to the fuel control unit, which measures fuel to the fuel nozzle. Fuel in excess of that required is returned to the engine-driven fuel pump. The fuel nozzle then sends fuel into the combustion chamber.

CHAPTER THREE REVIEW QUESTIONS

1. Match the statements in column one with the items in column two.

a.	_____ 20 gals.	1.	Component of fuel system
b.	_____ Fuel cell	2.	Crash resistant
c.	_____ Boost pump	3.	Fuel level for caution light
d.	_____ Shutoff valve	4.	Fuel cell capacity
e.	_____ 91 gals.	5.	Refueling system
f.	_____ Pressure feed		
g.	_____ Airframe fuel filter		
h.	_____ Gravity feed		
i.	_____ Quantity measuring system		

2. The boost pumps send (pressurized/unpressurized) fuel to the engine-driven fuel pump.

3. At what altitude can fuel vaporization occur?

   a. Above 6000'
   b. Above 5000'
   c. Above 4000'
   d. Above 3000'

4. The fuel pump caution light illuminates if boost pump pressure

   a. falls below 3.5 psi.
   b. falls below 6.5 psi.
   c. rises above 30 psi.
   d. rises above 34 psi.

5. With one boost pump operational, it is acceptable to perform maneuvers that would momentarily uncover the pump intake screen.

   a. True
   b. False

6. A float type fuel quantity indicating unit is installed in the

   a. lower section of the fuel cell.
   b. upper section of the fuel cell.
   c. lower and upper sections of the fuel cell.
   d. aft section of the fuel cell.

7. The fuel shutoff valve will remain in the last position selected in the event of

   a. engine-driven pump failure.
   b. airframe fuel filter stoppage.
   c. boost pump failure.
   d. electrical failure.

8. The impending bypass switch causes the __________ caution light to illuminate if fuel pressure drops below safe limits.

   a. fuel pump
   b. engine filter
   c. A/F fuel filter
   d. boost pump

9. The airframe fuel filter bypass valve routes fuel back to the fuel cell if fuel filter stoppage is experienced.

   a. True
   b. False

10. The fuel control unit receives fuel at _____ psi of pressure.

   a. 850-950
   b. 650-750
   c. 300-400
   d. 4-30

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CHAPTER THREE REVIEW ANSWERS

1. a. 3
   b. 1, 2
   c. 1
   d. 1
   e. 4
   f. 5
   g. 1
   h. 5
   i. 1

2. Pressurized

3. a

4. a

5. b

6. c

7. d

8. c

9. b

10. b

CHAPTER FOUR
TH-57B/C POWER TRAIN

400. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will identify the components of the TH-57 power train and state their associated functions.

401. ENABLING OBJECTIVES

Identify the components of the TH-57 power train.

1. State the type of lubrication system utilized in the main transmission.

2. Identify the components of the main transmission oil system and state the function of each component.

3. State the location of the Maindrive shaft and its function.

4. State the function and location of the freewheeling unit and its source of lubrication.

5. Identify the components of the tail rotor drive shaft and state their functions.

6. State the two functions of the tail rotor gearbox.

7. Identify the type of lubrication system utilized in the tail rotor gearbox.

402. TH-57B/C POWER TRAIN

The power train transfers power from the engine to the main and tail rotor systems. The TH-57 power train (Figure 4-1) consists of a transmission, main drive shaft (KAflex shaft), freewheeling unit, forward short shaft, oil cooler fan shaft, aft short shaft, five tail rotor drive shafts, and the tail rotor gearbox. A complete discussion of each of these components will be included in this chapter.

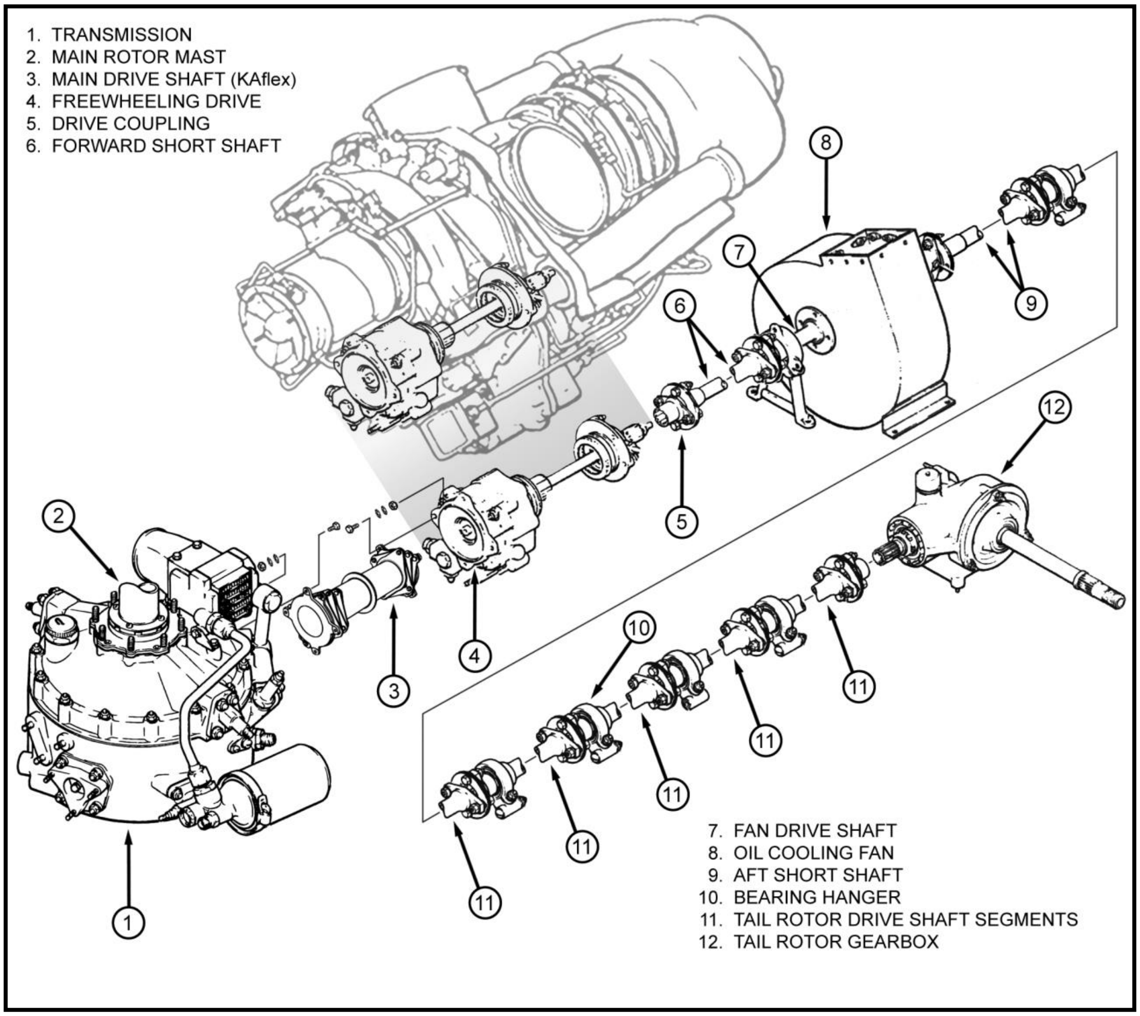

Figure 4-1 Power Train System

1. **Transmission**

The transmission is mounted on the cabin roof deck and has three points of support. Two spindles, one on each side of the transmission, and a drag link connected to the aft end of the lower case make up the three support points (Figure 4-2). Two A-shaped pylon support brackets (Figure 4-2) link the transmission to the airframe. The A-pylons contain spherical bearings, which mount over the spindles on each side of the transmission.

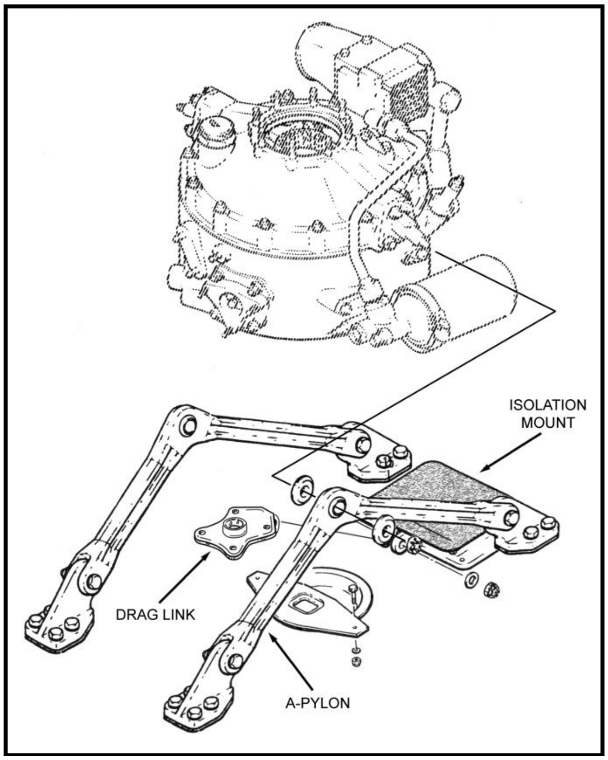

Figure 4-2 Main Transmission Mounting

The feet of the pylons are bolted to the cabin roof. Aft of the transmission is the isolation mount (Figure 4-2), which restricts the fore and aft tilting of the transmission. ***Its purpose is to align the transmission and isolate vibrations.*** The isolation mount is made up of layers of elastomer and metal, which allow the transmission to move when under a load, but will return it to its original position when the load is relieved. Due to this flexibility, there is the possibility, it may tilt out of limits and damage some components. Located in front and attached to the drag link plate, is a spike that protrudes down from the bottom of the transmission. This spike extends down into an opening called the spike well and is surrounded by a plate. The spike is free to swing inside the opening, but should the transmission swing excessively, as in a hard landing, it will contact the plate. ***An extremely hard landing can cause the rivets holding the spike well to shear or the spike may be torn from its mounting.*** However, in normal operations, you can have spike contact, which will serve to limit the movement of the transmission. The isolation mount becomes more flexible with age, which will allow the transmission to move more freely. This will allow the spike to contact the plate more frequently during landings. Furthermore, contact may occur during hovering or flight. If these events occur, they should be reported to maintenance for correction.

The transmission provides two stages of gear reduction with an ***overall*** gear reduction of 15.22 to 1.0. The first stage is located in the lower case and consists of an input gear, ring gear, and shaft support. The second stage of the transmission is located directly above the first stage and consists of the sun gear shaft, planetary gears, and ring gear. The input gear (Figure 4-3), driven by the barbell shaft, is rotating at 6000 RPM and the output to the rotor mast is rotating at 394 RPM.

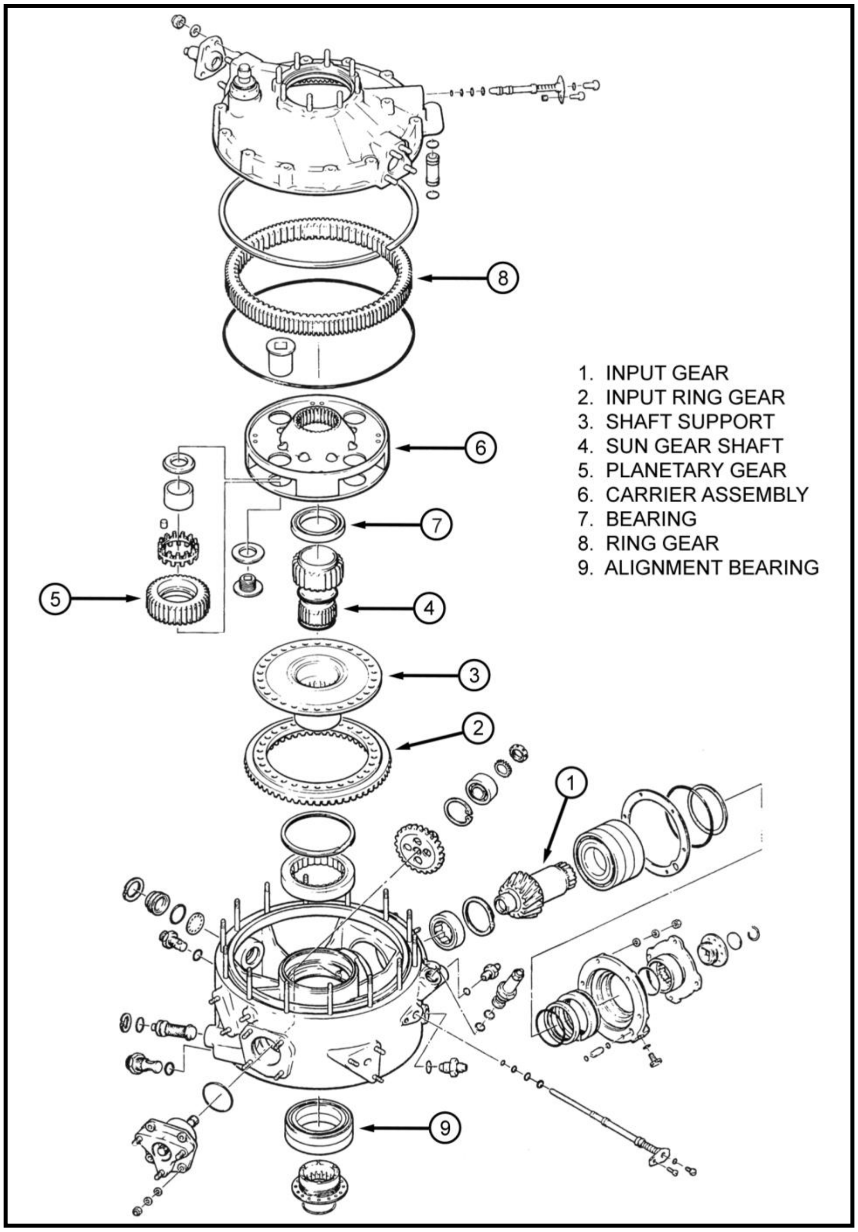

Figure 4-3 Transmission Assembly

2. **Transmission Oil System**

Lubrication for the transmission is provided by a ***wet sump/pressure lubrication system,*** which includes a pump, relief valves, filter, spray jets, temperature bulb, and an oil cooler (Figure 4-4). The lower case of the transmission is the wet sump for the system, which has a total capacity of five U.S. quarts.

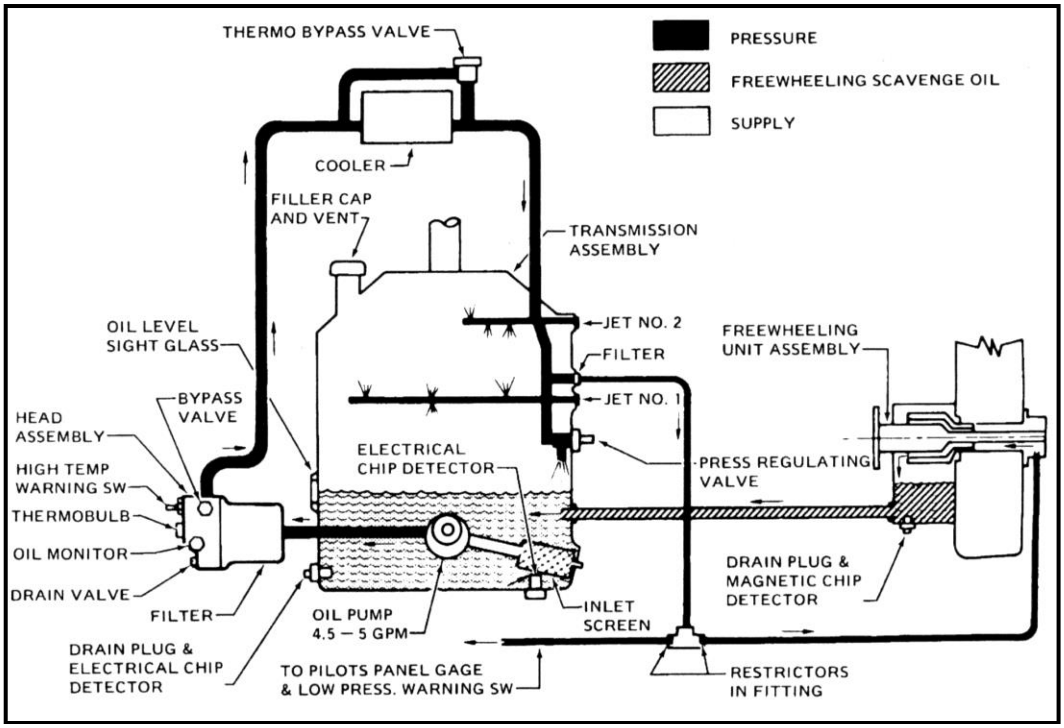

Figure 4-4 Transmission Oil Schematic

First in the system is ***the oil pump, which is mounted internally in the transmission lower case and is driven by the transmission accessory gear drive.*** The accessory drive gear is splined to a shaft that passes through the oil pump. ***This shaft not only drives the internal oil pump; it also drives the hydraulic pump and the N_r tach generator, which are mounted piggyback with each other (Figure 4-5).***

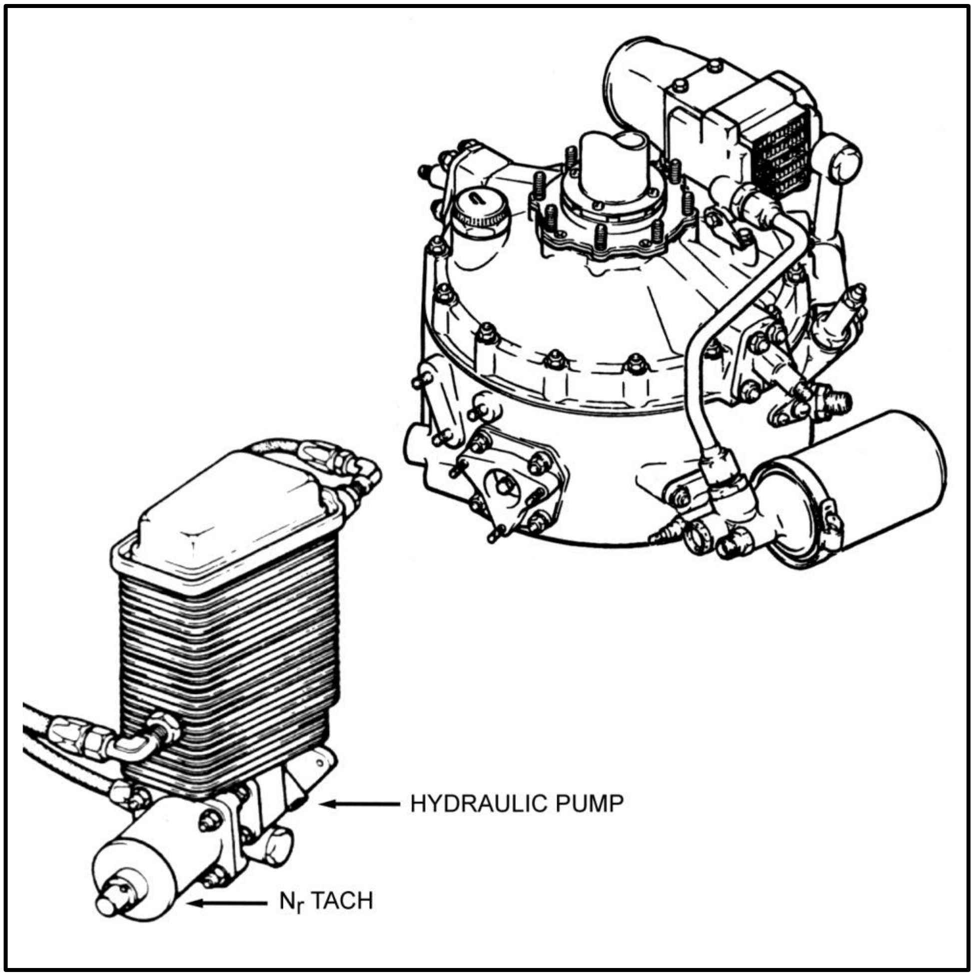

Figure 4-5 Hydraulic Pump and N_r Tach Generator Mounting

The oil pump draws oil from the sump and sends it to the filter. The oil filter is located on the port (left) side of the transmission casing and uses a replaceable filter element. The oil filter head provides an attachment point for the filter and incorporates a temperature bulb, high temperature sensor switch, oil bypass valve, oil monitor, and a drain valve (Figure 4-6).

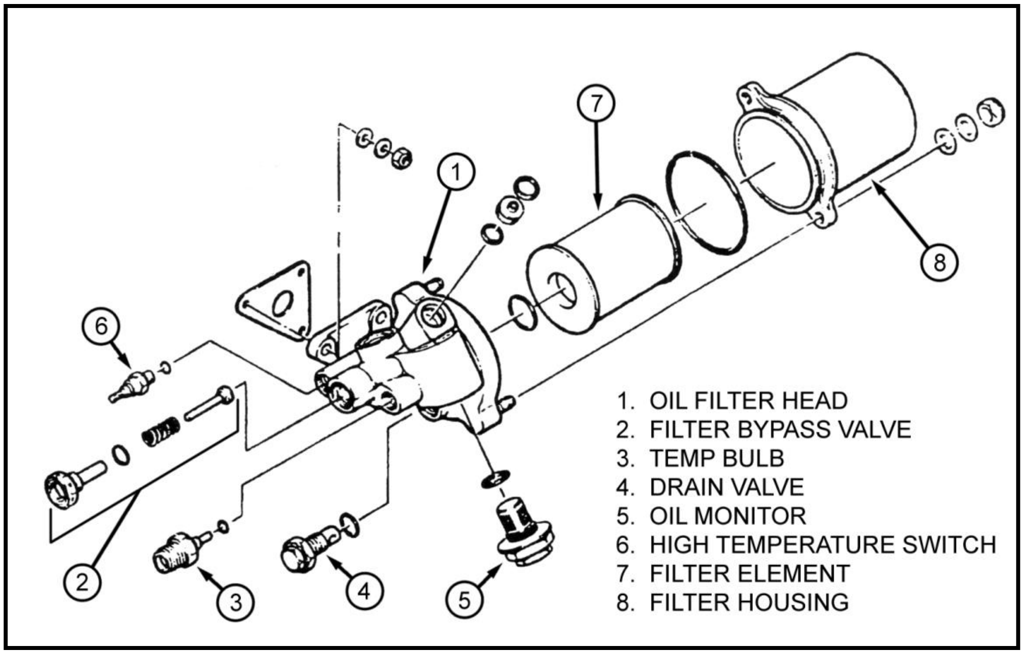

Figure 4-6 Transmission Oil Filter Assembly

As oil enters the filter head, ***temperature is sensed by the thermobulb, which gives an indication on the oil temperature gauge in the cockpit. If the oil temperature exceeds 110º Celsius, the high temperature sensor switch closes a circuit that illuminates the TRANS OIL TEMP caution light.*** In normal operation, a bypass valve allows oil to enter the filter. If, however, the filter becomes clogged to the point that differential pressure exists, the bypass valve will allow the oil to bypass the filter element. Also, located on the filter head is a magnetic chip detector incorporated with a screen. This is called an oil monitor and it is NOT part of the chip detector CAUTION system. It is checked only after metal particles have been found in the system on one of the other chip plugs. A drain valve on the filter head allows maintenance to drain oil from the filter. After the oil passes through the filter, it goes to the transmission oil cooler mounted to the transmission case (Figure 4-7). The purpose of the cooler is to regulate the oil temperature before it flows to the transmission and freewheeling unit. The oil cooler uses air supplied, via ducting, from the oil cooling fan located aft of the engine.

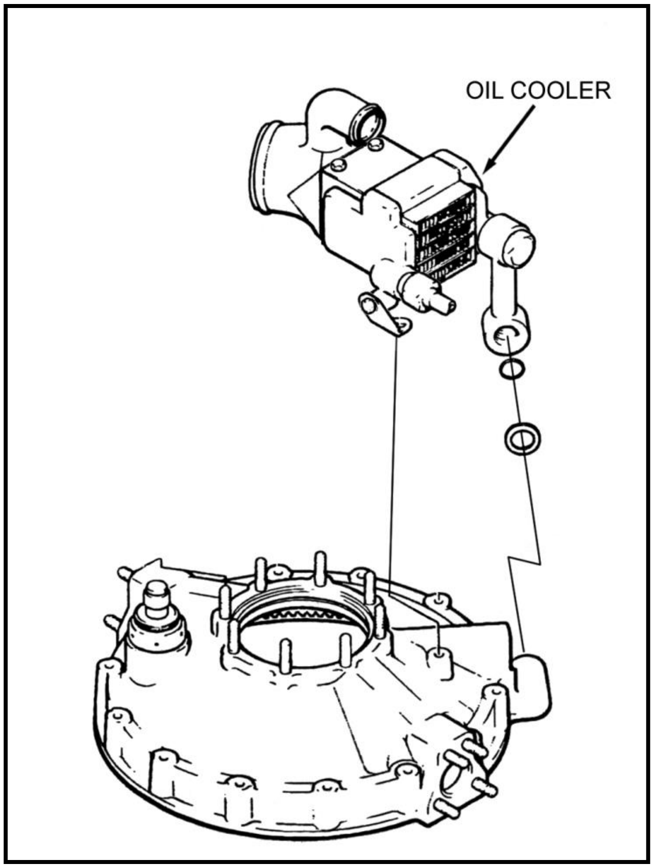

Figure 4-7 Transmission Oil Cooler

This air is blown across a single core radiator in the cooler. A thermal bypass valve is located on the outlet side of the cooler. It controls the temperature of the oil by allowing the oil to bypass the cooler when the oil temperature is low. The oil flows from the cooler to two sets of jets located in the upper and lower transmission case. Oil passing through the jets flows into the transmission and returns to the sump. There is a pressure regulating valve which limits the overall system pressure. It is a spring relief type valve which bleeds off pressure by passing oil back to the sump. The valve pressure can be adjusted and is located on the transmission casing aft of the filter. Not all of the oil goes to lubricate the transmission, some exits the transmission and flows through an external line to a T-fitting. This T-fitting distributes the oil in two directions and it contains restrictors that reduce the volume of oil passing through it. One line goes to a direct reading transmission oil pressure gauge in the cockpit. A low pressure sensor switch is connected in this line and if the pressure drops below red line, a circuit is closed and the TRANS OIL PRESS caution light is illuminated in the cockpit. The other line from the fitting goes to the freewheeling unit, where the oil lubricates the sprag clutch. The oil then runs down into the freewheeling sump where a return line passes it back into the main transmission sump to start the process over again.

Two electric chip detectors are located on the lower starboard side of the transmission and illuminate the TRANS CHIP caution light in the cockpit when metal particles are present. One of the detectors also serves as the drain plug for the transmission case (Figure 4-8). Some aircraft have an additional electric-magnetic chip detector on the upper port side. The accumulation of metal particles on the various chip detectors will indicate normal wear, as well as excessive deterioration. In either case, maintenance personnel must determine the status of the aircraft.

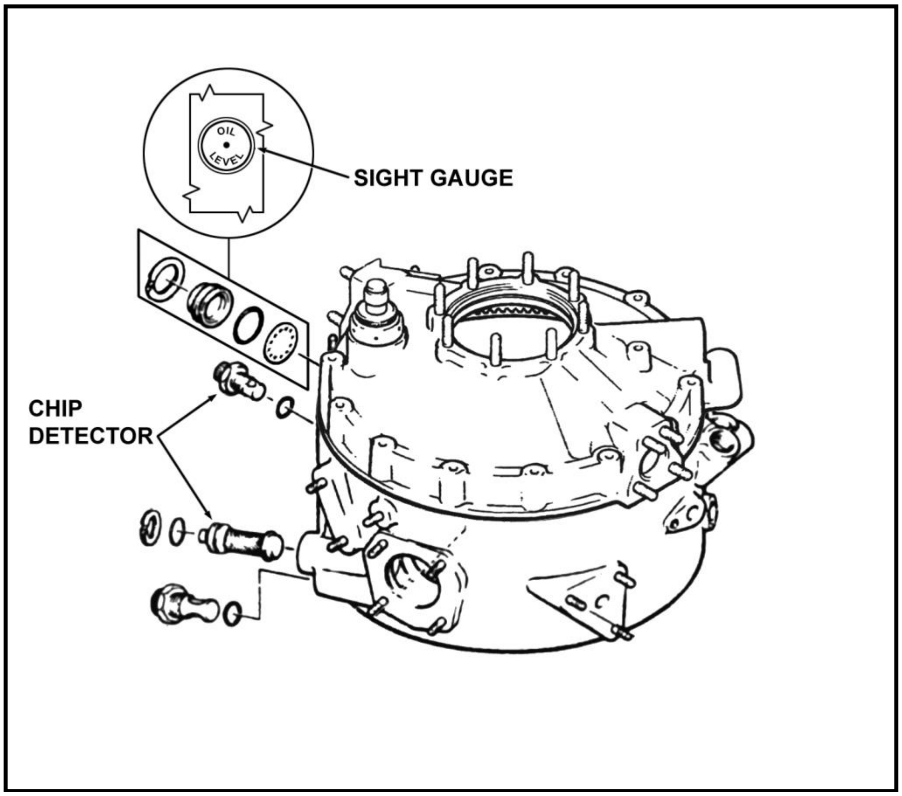

Figure 4-8 Transmission Chip Detectors and Oil Level Sight Gauge

3. **Freewheeling Unit**

The freewheeling unit incorporates an outer race, an inner race, and a sprag clutch assembly. During autorotation and shutdown, the sprags make minimal contact with the races. The inner race shaft passes through the center of the outer race and passes through the accessory gearbox. The front end of the inner race shaft connects directly to the main drive shaft and the aft end connects the tail rotor drive. The inner race shaft is free to turn by itself except when the sprag clutch is engaged (Figures 4-9 and 4-10).

To reduce friction and ensure the sprags release, the freewheeling unit is lubricated by the transmission oil system, which is still in operation during autorotation. The oil is fed under pressure into the sprag clutch assemble, and as it turns, centrifugal force throws the oil into the case, where it collects and returns to the transmission case via a return oil line. An electric chip detector will illuminate the TRANS CHIP caution light in the cockpit when metal particles are present.

The sprag clutch assemble is the main component of the freewheeling unit and provides the means to disconnect the power train from a failed or secured engine (Figure 4-11). The sprags are held in a cage assembly, and rotation of the outer race by the engine jams the sprags between the inner and outer races and this tight fit locks the inner and outer races together (Figure 4-11). If the outer reach stops turning because of engine failure or shutdown, the inner race and shaft are free to turn because of the action of the sprags. The sprags are forced to pivot to the unjammed condition that allows the power train to freewheel, which is necessary for autorotation.

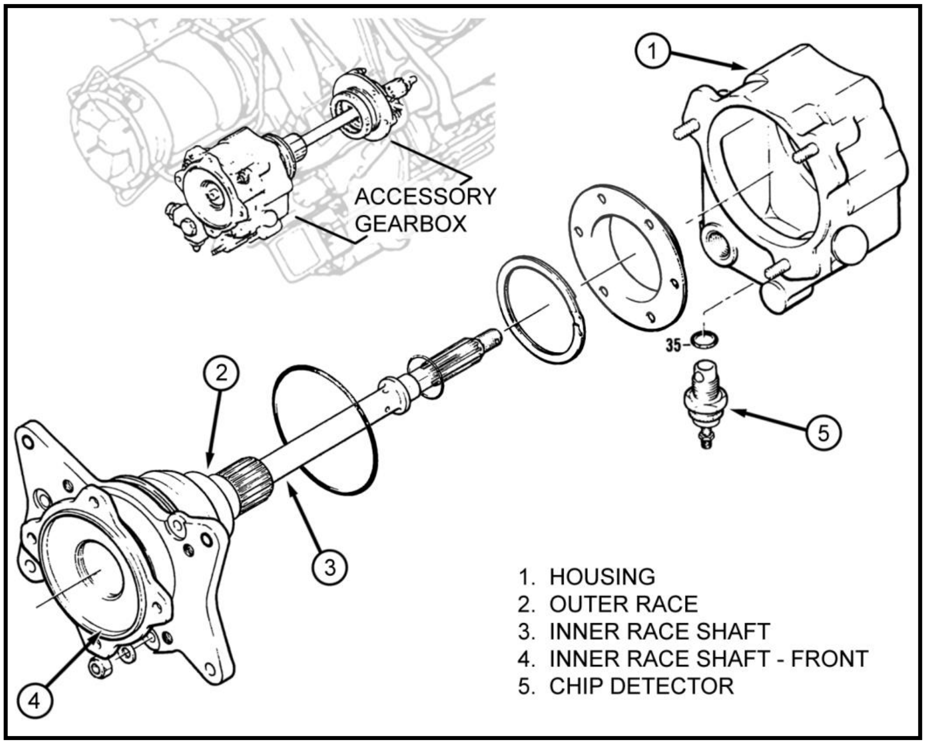

Figure 4-9 Freewheeling Unit

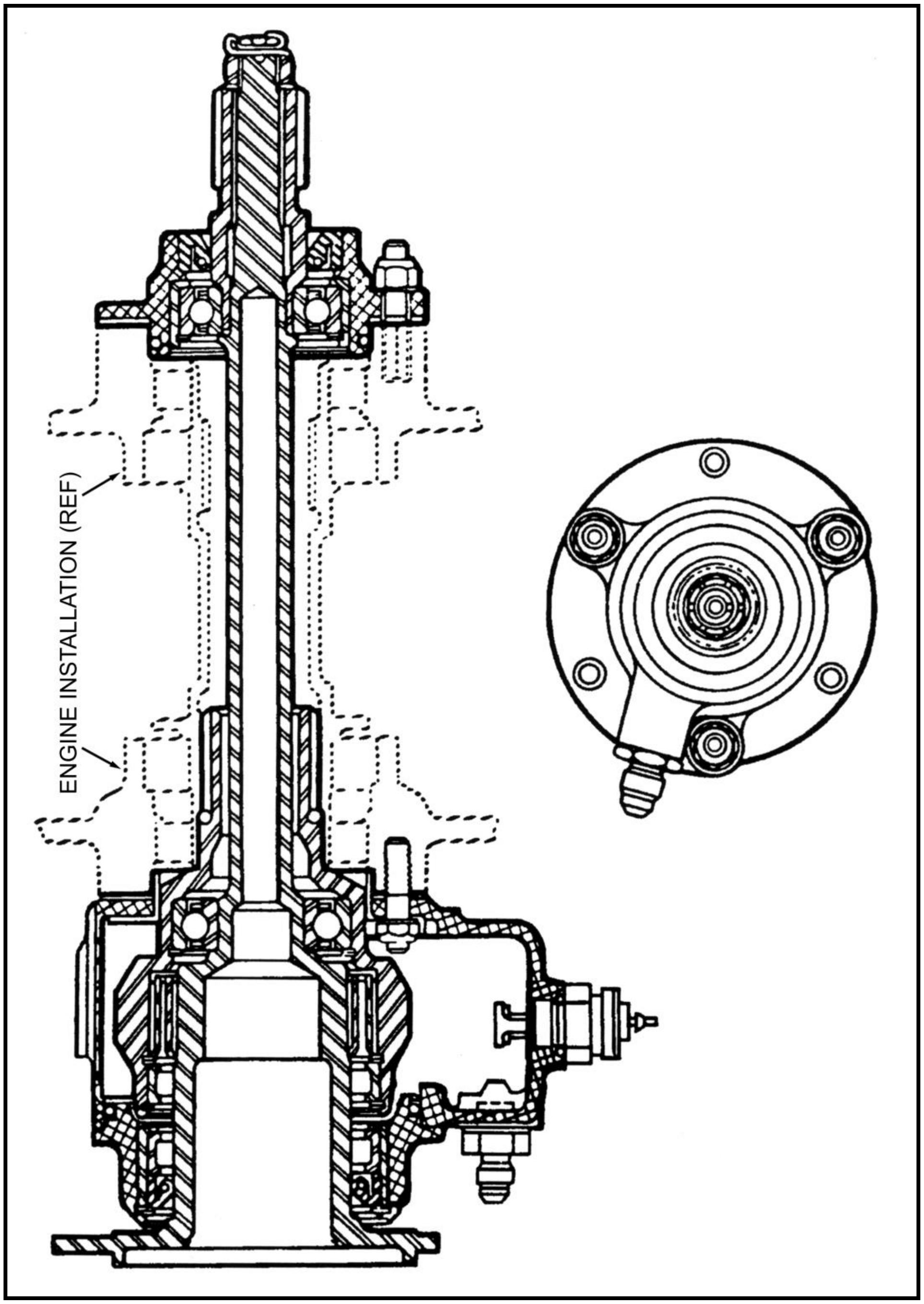

Figure 4-10 Freewheeling Unit

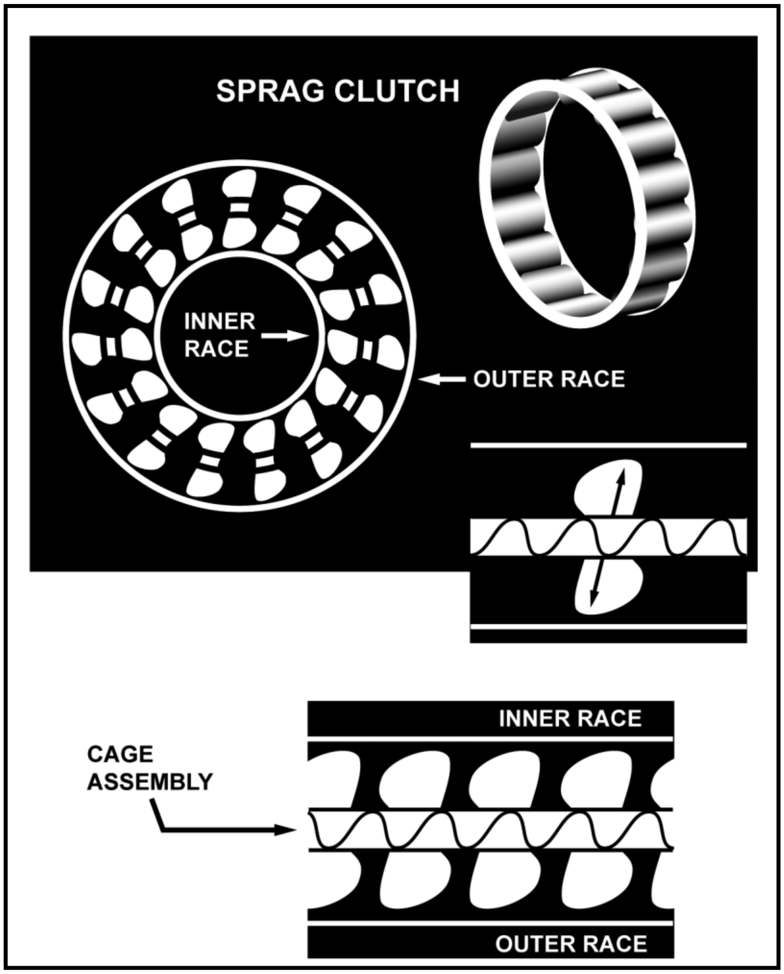

Figure 4-11 Sprags

4. **Engine To Transmission Drive Shaft (KAflex Shaft)**

The KAflex shaft has a flexible splined coupling on each end. The flexibility of these couplings allows for momentary misalignment of the shaft, caused by movement of the transmission during flight. The aft end of the KAflex shaft is connected to the freewheeling unit. The shaft passes through a rectangular opening in the firewall and connects to the transmission input pinion (Figure 4-12).

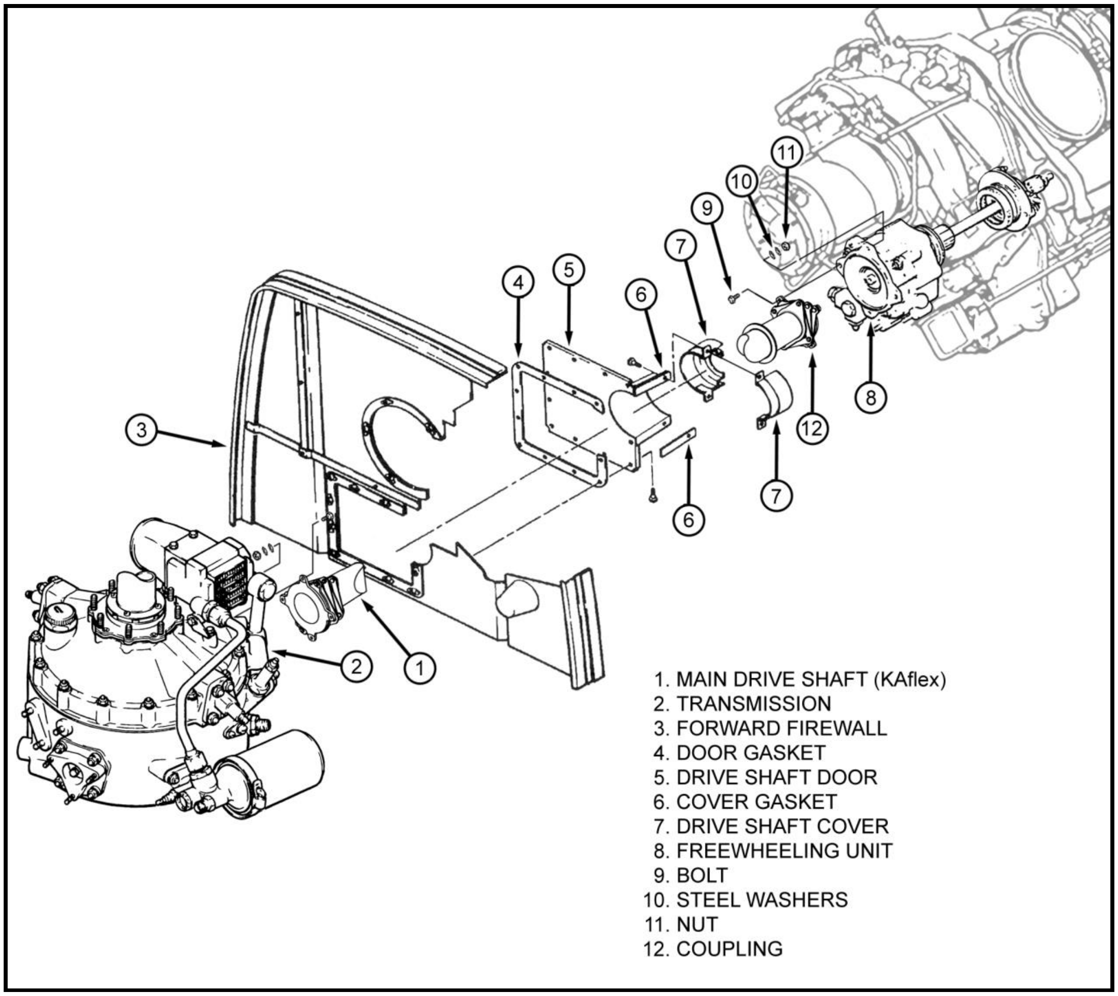

Figure 4-12 Engine to Transmission Drive Shaft Assembly

5. Tail Rotor Drive

The tail rotor drive consists of the forward shaft, oil cooler fan drive shaft, aft short shaft, five tail rotor drive shafts, and the tail rotor gearbox (Figure 4-13). The drive shafts are supported by two oil cooler bearing supports and five hanger bearings. These align and support the shaft along the length of the tailboom. The forward and oil cooling fan shafts are steel, while the shafts aft of the oil cooling fan are aluminum for weight savings and to allow for proper weight and balance. At each end of the aluminum shafts are steel couplings bonded or splined to the shaft. If the coupling is bonded, it will have a pin extending through the coupling and shaft. This pin turns freely, and if the bonding should fail, it will jam the pin in place as the drive shaft is rotated. The sections are connected together with nine flexible Thomas couplings. These couplings consist of thin laminated steel disks stacked together in a set. They allow for shaft twisting and cabin-to-tailboom flexing.

The oil cooler drive shaft serves two purposes. First, it is a part of the tail rotor power train and second, as the shaft turns, the oil cooler fan turns with it. The fan is a squirrel-cage type impeller fan that provides air flow flexible ducting to the engine, transmission, and hydraulic oil cooling systems.

The tail rotor gearbox is the last component of the tail rotor drive system. The gearbox serves two purposes. First, it changes the direction of drive by 90º, and second, it provides for a gear reduction. The drive shaft 6000 RPM is reduced to approximately 2554 RPM at 100% N_r. The gearbox housing is made of casted magnesium and is bolted to the tail section by four bolts. The case incorporates an oil level sight glass, a combination magnetic chip detector/drain plug, and a vented cap. The chip detector is electric, and when activated by metal particles, it illuminates the tail rotor chip light in the cockpit. The gearbox has a self-contained splash type lubrication system with an oil capacity of 3/8 of a pint.

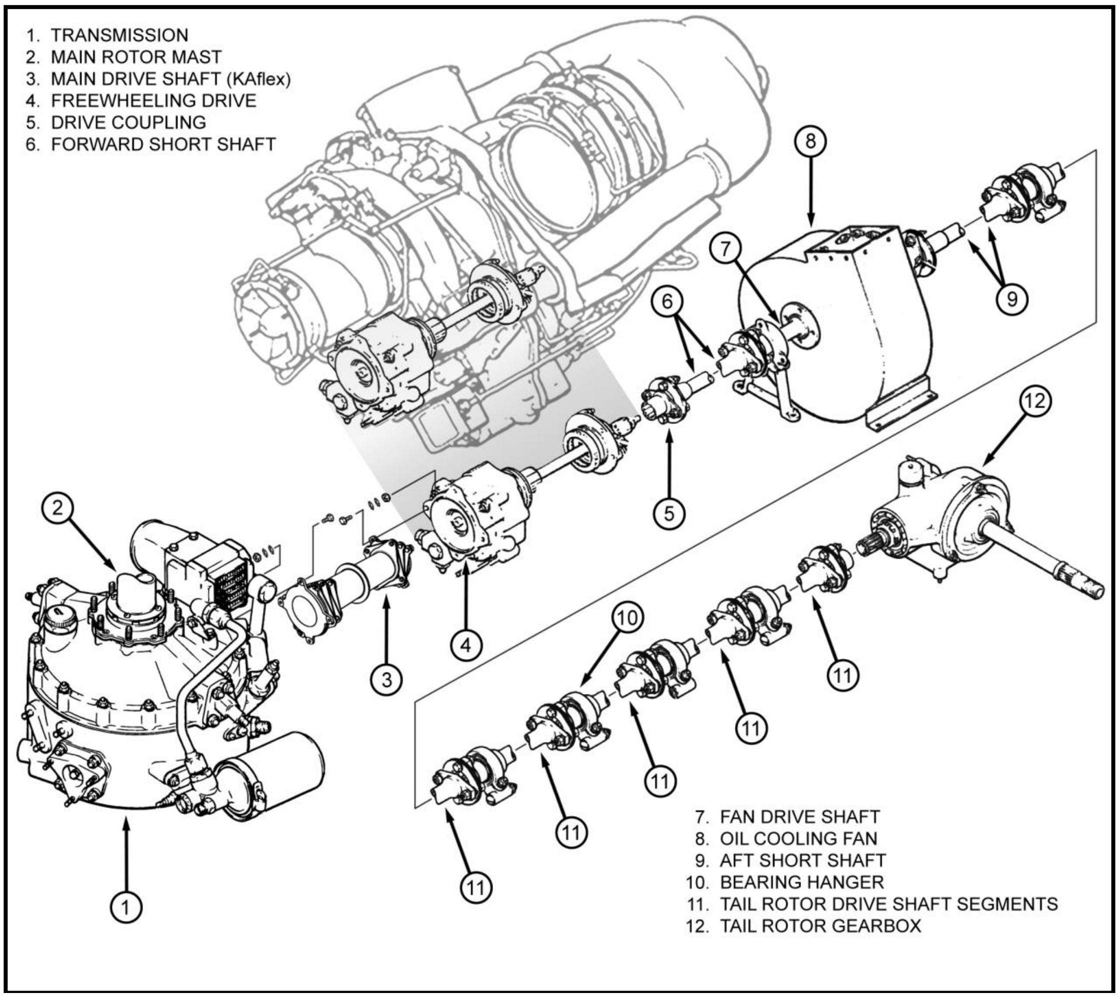

Figure 4-13 Main and Tail Rotor Drive

CHAPTER FOUR REVIEW QUESTIONS

1. The main rotor drive includes the _____ _____ and _____ _____.

2. What is the purpose of the isolation mount?

3. A sheared spike well or the spike torn from its mounting would be the indication of an _______ ________ ______________________________.

4. At 100% N_r the input to the transmission is rotating at ___ RPM and the rotor mast rotates at ____ RPM.

5. Lubrication for the transmission is provided by a _____ _____/_____ lubrication system.

6. The transmission oil pump is driven by the ______ ______ ______.

7. The shaft that drives the transmission oil pump also drives the _____ _____ and _____ _____.

8. If the transmission oil temperature exceeds 110°C, the TRANS OIL TEMP caution light illuminates.

   a. True b. False

9. If the transmission oil pressure drops below ___, the TRANS OIL PRESS caution light illuminates.

10. What is the purpose of the transmission oil cooler?

11. The freewheeling unit chip detector is electrical and will illuminate a caution light when meal particles are present.

   a. True b. False

12. How does the freewheeling unit function in an autorotation?

13. If the main drive shaft fails, what drives the tail rotor?

14. What lubrication system provides lubrication to the freewheeling unit?

15. What type of lubrication system is used in the tail rotor gearbox?

16. What unit transmits power from the power outlet shaft to the barbell shaft?

CHAPTER FOUR REVIEW ANSWERS

1. Main shaft…main transmission
2. Align the transmission and isolate vibrations
3. Extremely hard landing
4. 6000…394
5. Wet sump/pressure
6. Accessory gear drive
7. Hydraulic pump… N_r tach generator
8. A
9. Minimum
10. Regulate the oil temperature before it flows to the transmission and freewheeling unit
11. True
12. It allows the power train to rotate free of the engine
13. The engine
14. Transmission lubrication system
15. Self-contained splash type
16. Freewheeling unit

CHAPTER FIVE
MAIN ROTOR, TAIL ROTOR, AND FLIGHT CONTROL SYSTEM

500. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will state the major components and functions of the main/tail rotor and flight control systems.

501. ENABLING OBJECTIVES

1. State the major components of the main rotor system.

    a. Describe the design of the main rotor system.

    b. State the purpose of the splined trunnion.

    c. State the type of mounting used between the trunnion and mast of the main rotor.

    d. State the purpose of preconing.

    e. State the purpose of the tension torsion strap.

    f. Describe the purpose of the latch bolt.

    g. Describe the method used to ensure high rotational inertia for autorotations.

    h. State the purpose of the flap restraint kit.

        - Describe the operation of the flap restraint kit.

    i. State the need for a rotor brake.

        i. Differentiate between the TH-57 hydraulic system and the rotor brake hydraulic system.

        ii. State the type and location of the gauge associated with the TH-57 rotor brake.

2. State the function of the tail rotor system.

    a. Describe the tail rotor system.

    b. Identify the major components of the tail rotor system.

        - Describe the construction of the tail rotor blades.

    c. State the purpose of blade doublers.

d. State the purpose of the balance wheel.

e. Identify the component which limits tail rotor flapping.

3. Identify the type of flight control system used on the TH-57.

a. Identify the three flight control systems.

b. State the purpose of the cyclic control.

- Describe the sequence of events with a cyclic input.

c. Identify the type of boost used with the flight controls.

d. State the purpose of the collective control.

- Describe the sequence of events with a collective input.

e. State the purpose of the anti-torque tail rotor.

f. Describe the composition of the tail rotor blades.

g. Recognize components of the tail rotor system and their function.

h. Describe the sequence of events with a tail rotor input.

502. TH-57 MAIN ROTOR, TAIL ROTOR, AND FLIGHT CONTROL SYSTEMS

1. Main Rotor Assembly

The main rotor design is a two-bladed, semi-rigid, flapping type rotor system with an underslung hub mounting (Figure 5-1).

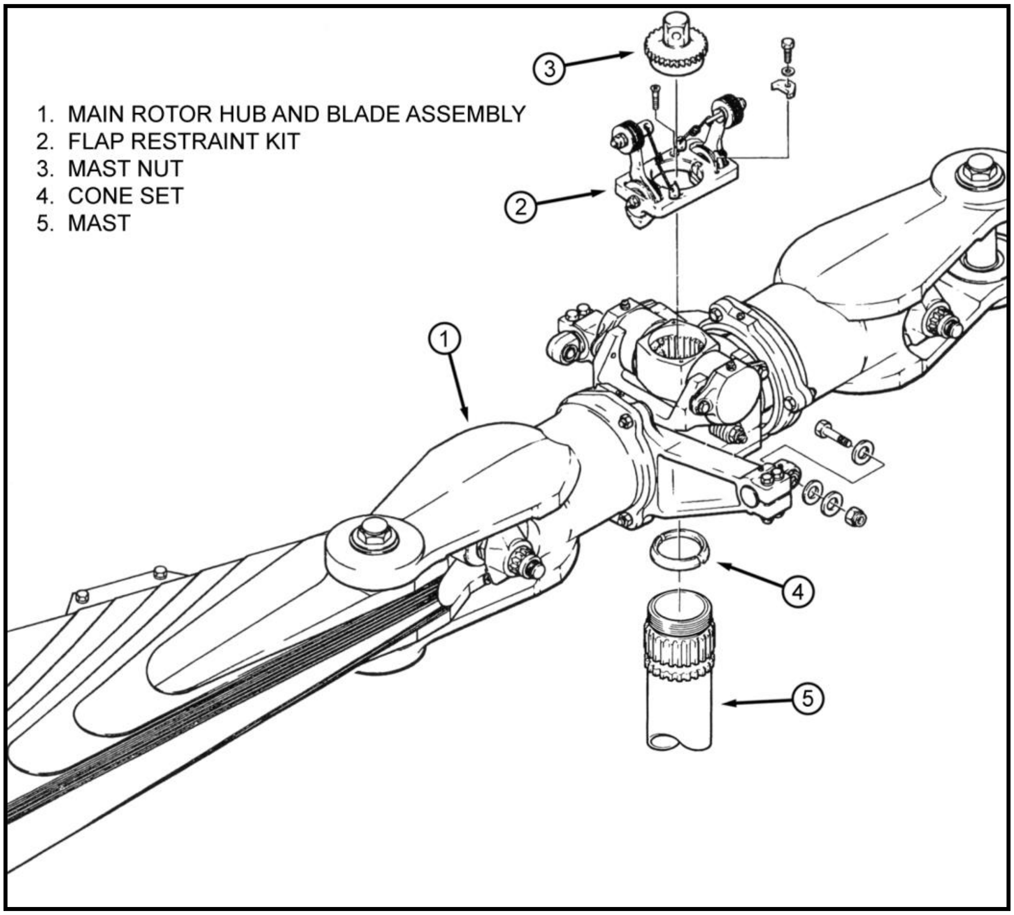

Figure 5-1 Main Rotor

The major components of the main rotor are the splined trunnion, yoke, tension torsion-straps, blade grips, pitch change horns, flap restraint assembly (kit), and the main rotor blades.

The splined trunnion is splined mounted to the mast and provides the mounting point for the yoke assembly. The splined trunnion provides the flapping axis for the main rotor. (Figures 5-1 and 5-2.)

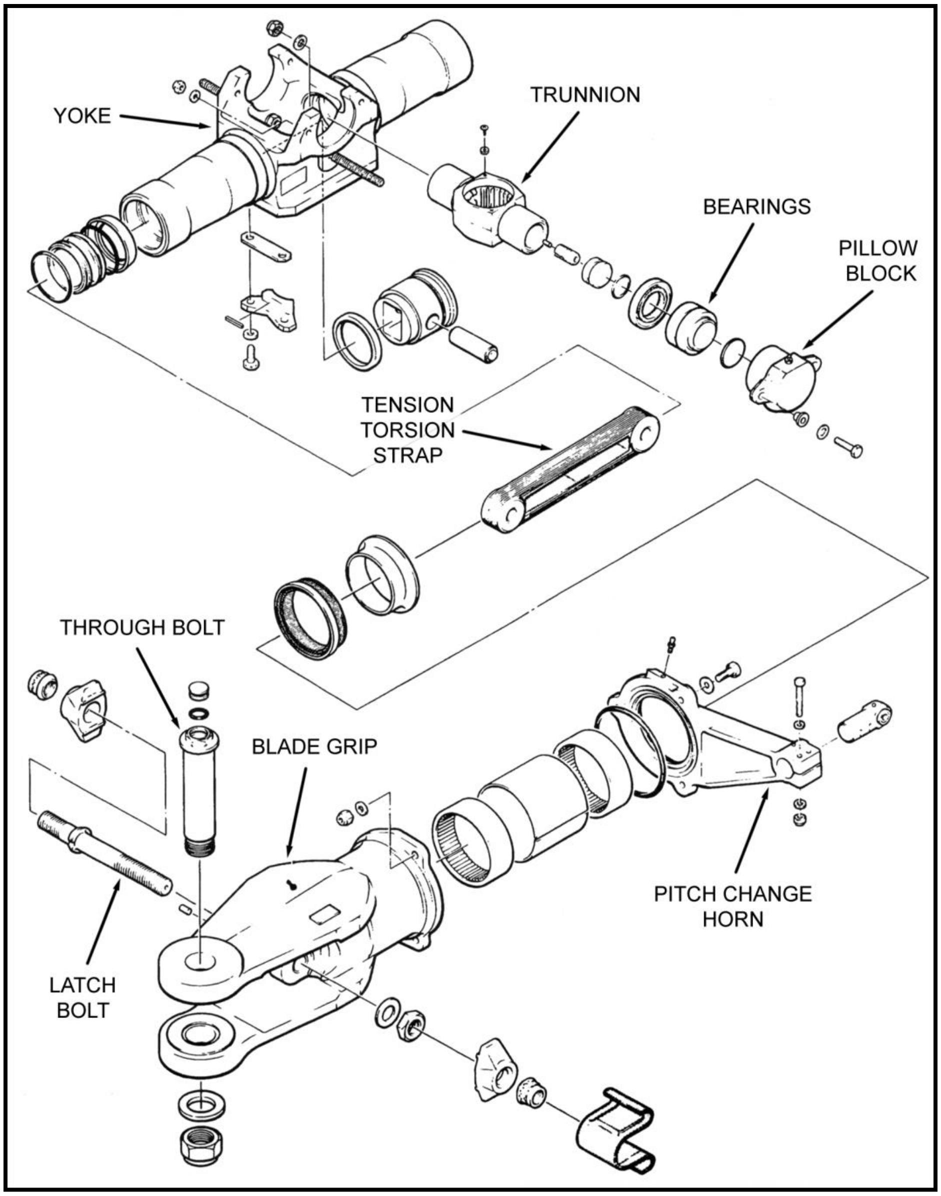

Figure 5-2 Yoke and Trunnion Assembly

The yoke is mounted to the splined trunnion by pillow blocks. The pillow blocks (Figure 5-2) have centering provisions for the yoke and also contain bearings that allow the main rotor to flap. Notice also the mounting point on the yoke is above the yoke centerline. With the mounting point above the yoke centerline, the yoke will be below the top of the mast (underslung). Underslinging corrects for geometric imbalance caused by tilting the rotor system. Another feature of the yoke is the ***2 1/4° of preconing***. Preconing helps relieve bending stress of the yoke, blade grips, and the root end of the rotor blade. (Figure 5-3.)

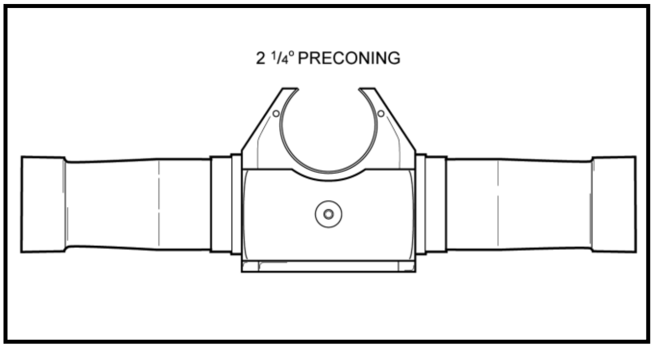

Figure 5-3 Yoke

(Underslinging and coning is covered in more detail in the Helicopter Aerodynamics Workbook.)

Running through the center of each yoke arm is a tension torsion strap. The strap is attached to the inboard part of the yoke by a retention cap and pin. The strap assembly is made of many wraps of wire around two spools and is covered with a protective coating of rubber (Figure 5-2). The tension torsion strap will absorb centrifugal forces and will twist to allow for pitch change action. The tension torsion strap assembly connects and holds the blade grip to the yoke assembly. A latch bolt is used to connect the blade grip and the strap assembly. The blade grips provide a mounting point for the rotor blades and pitch change horns (Figure 5-2). The pitch change horns receive control inputs from the pitch control tube and cause the blade grips to change pitch angle around the yoke assembly. Mounted to the blade grip by a single vertical through bolt is an all-metal rotor blade (Figure 5-4).

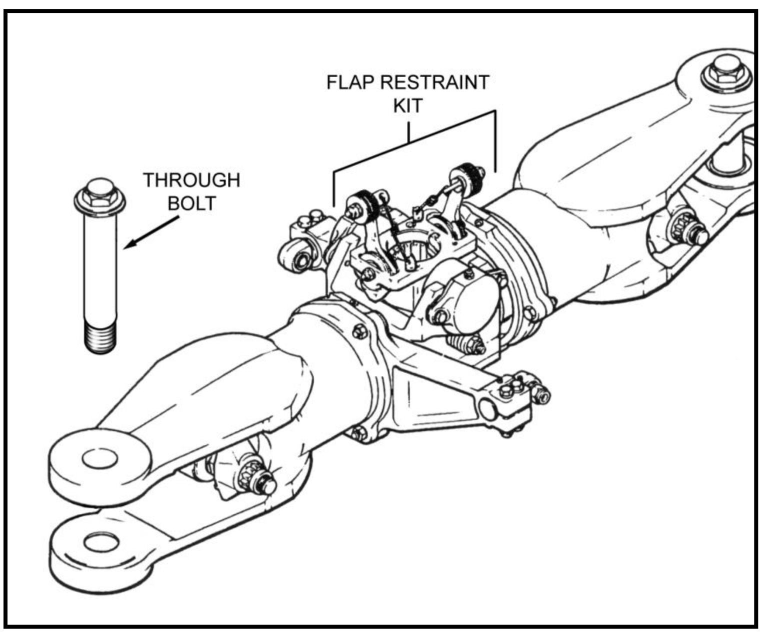

Figure 5-4 Blade Grip Assembly

The vertical through bolt not only secures the rotor blade but is hollow inside to allow balance weights to be installed. The rotor blades are of a nonsymmetrical droop snoot design composed of an extended aluminum alloy nose block, trailing edge, and skin sheets over an aluminum honeycomb filler (Figure 5-5).

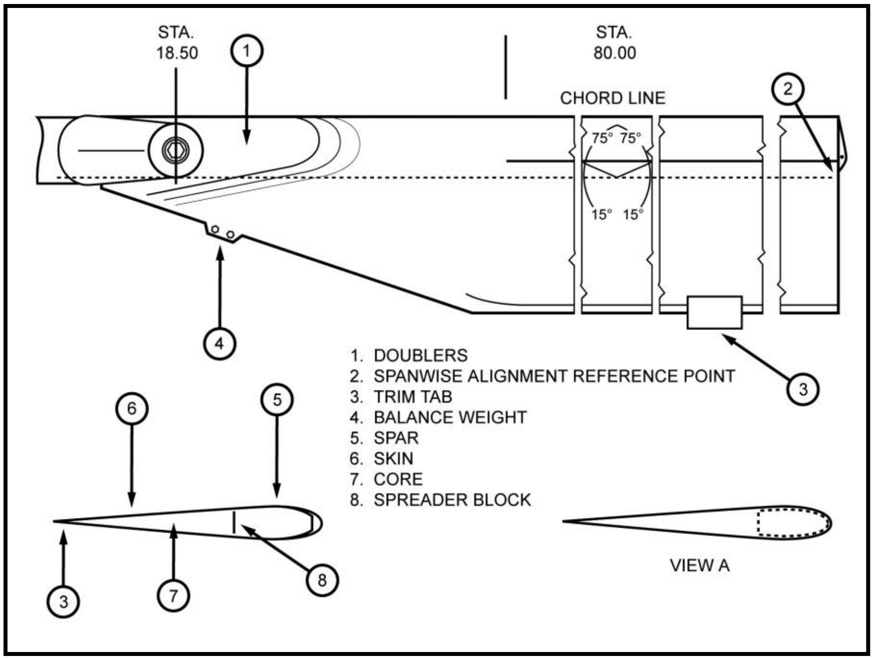

Figure 5-5 Main Rotor Blade

Blade strength is increased by bonding doublers (laminations) on the root end. To insure high rotational inertia for autorotational flight, weights have been added at the tip and mid-span of each blade. The total weight of each blade is approximately ninety-four pounds and has a chord of thirteen inches. Since the rotor is a flapping type rotor, damage can occur to the tail boom due to excessive blade flapping; particularly during startup or shutdown when rotor RPM is lower. To prevent excessive flapping, a flap restraint assembly is mounted to the top of the splined trunnion and is a flyweight and spring type restraint assembly (Figure 5-6.)

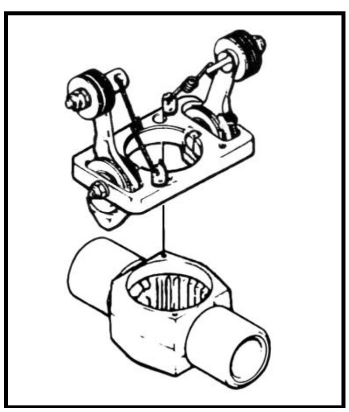

Figure 5-6 Flap Restraint Assembly

At low rotor RPM, springs will hold the restraint arms in place and prevent excessive flapping. As RPM is increased, flyweights overcome spring tension and the restraint arms move, allowing full flapping motion.

2. **TH-57C Rotor Brake**

Installing a rotor brake system provides a means of rapidly decelerating the rotor after engine shut down. A rotor brake is found only on the TH-57C. The rotor brake system has its own hydraulics and is totally **independent of the aircraft hydraulic system.** The following brief discussion describes how the rotor brake improves the capabilities of the TH-57C model. For our discussion, we will separate the rotor brake into the pump section and the brake unit.

The pump section is located next to the overhead console and consists of a pump handle, master cylinder, and reservoir. The system reservoir is serviced through a filler cap on top of the reservoir. Pulling the lever to the down position activates the master cylinder. ***The master cylinder will supply hydraulic fluid at a pressure of 100 to 120 psi to the system. System pressure is indicated on a direct reading gauge located overhead between the pilots. The disc brake assembly is mounted to the forward end of the free wheeling assembly. A disc is mounted on the main drive shaft so braking action is applied to the main drive shaft and not the free wheeling unit.*** The single disc unit (Figure 5-7) has a dual pad system similar to wheel brakes found in general aviation aircraft. With the handle down, ***fluid under pressure is applied to the dual brake linings. The dual brake linings compress against a disc mounted on the main drive shaft and decelerate the main rotor.*** Normal initial engagement of the rotor brake is 38 to 30% rotor RPM after engine shutdown. Engagement above 38% N_r will put a heavy load on the rotor brake, and below 30% N_r, the brake will tend to grab, causing a sudden stoppage of the rotor system. If the rotor brake must be applied below 30% N_r, apply it slowly to prevent internal transmission damage.

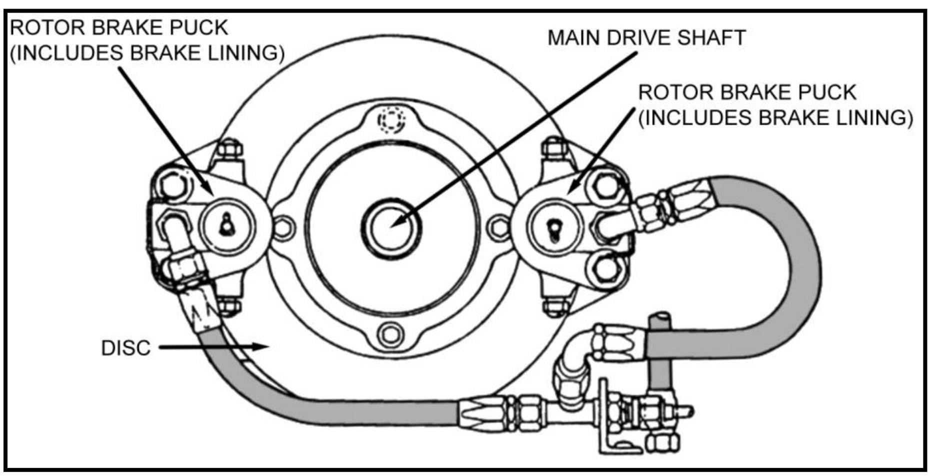

Figure 5-7 Rotor Brake

3. **Tail Rotor Assembly**

The TH-57, as with all single rotor helicopters, must have a system to counteract the main rotor torque effect. The main rotor blades rotate counterclockwise and, in powered flight, the fuselage will attempt to rotate clockwise. To compensate for the torque effect, the TH-57 has a tail rotor mounted on and driven by the tail rotor gearbox shaft (Figure 5-8.)

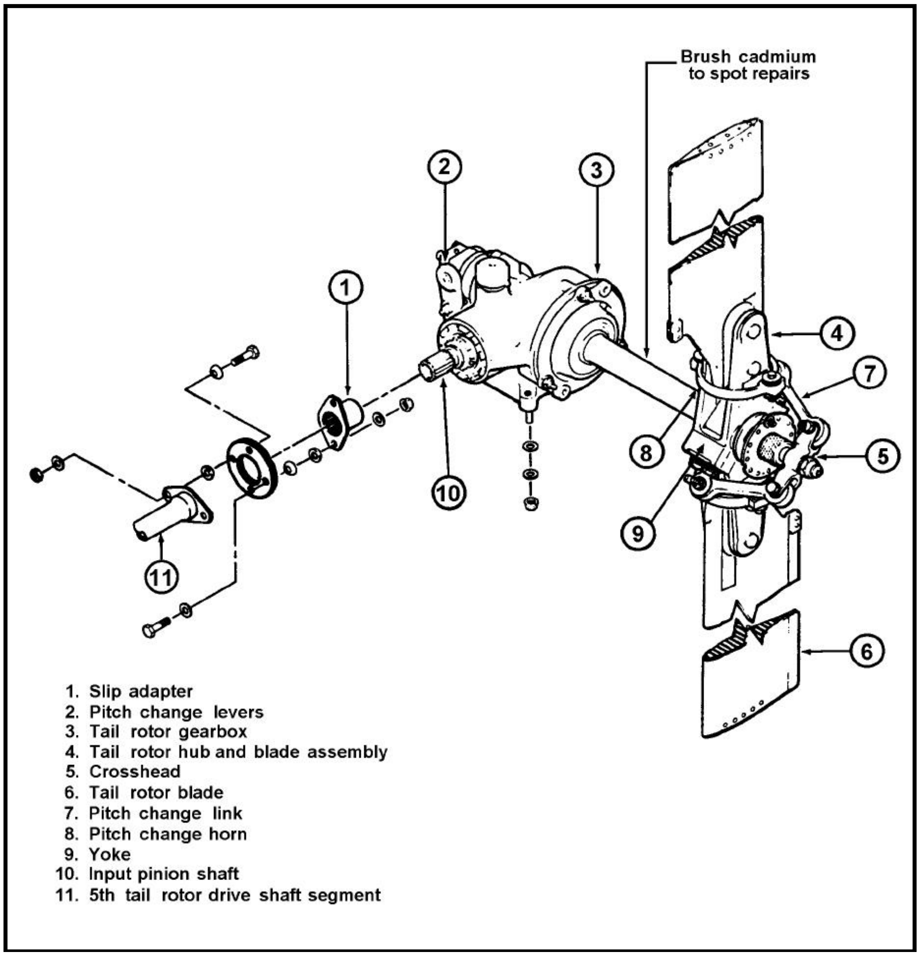

Figure 5-8 Tail Rotor and Gearbox Assembly

The tail rotor is a two-bladed, semi-rigid, flapping type system. The blades are all metal and give the tail rotor a diameter of five feet five inches. The major components of the tail rotor are the rotor blades, pitch change horns, cross head, control tube, balance wheel, static stop, and yoke assembly. The rotor blades are constructed of aluminum honeycomb, covered by a stainless steel skin. Stainless steel doublers have been added at the root end for added strength. To reduce erosion, a stainless steel abrasion strip has also been added to the leading edge. The root end consists of an aluminum alloy retention block. Two spherical bearings are mounted in the retention block to provide mounting for the rotor blade to the yoke. Each end of each blade had ballast stations for mass balancing. At the time of manufacture, weights are added as required to balance the blade. Before the tail rotor assembly is installed, the assembly must be statically balanced spanwise and chordwise. Spanwise balance is accomplished by the use of washers on the blade bolts. Chordwise balance is accomplished by using weights and washers on the trunnion bearing housing retaining bolts. The pitch horn is mounted to the tail rotor blade (Figure 5-9). The pitch change horn receives input from the crosshead, via the pitch change links and changes the pitch angle for the tail rotor blades. The crosshead is mounted to the end of the control tube by a single self-locking nut. As the control tube extends or retracts, the crosshead moves the pitch change links, changing the pitch angle of the tail rotor blade. Mounted on the tail rotor gearbox shaft next to the crosshead is the balance wheel. ***The balance wheel is used for dynamic balancing*** of the tail rotor system.

Dynamic balancing is accomplished by changing the weights mounted in the holes around the balance wheel. Next to the balance wheel and also mounted to the gearbox shaft is the static stop. ***The static stop limits the amount of flapping by the tail rotor.***

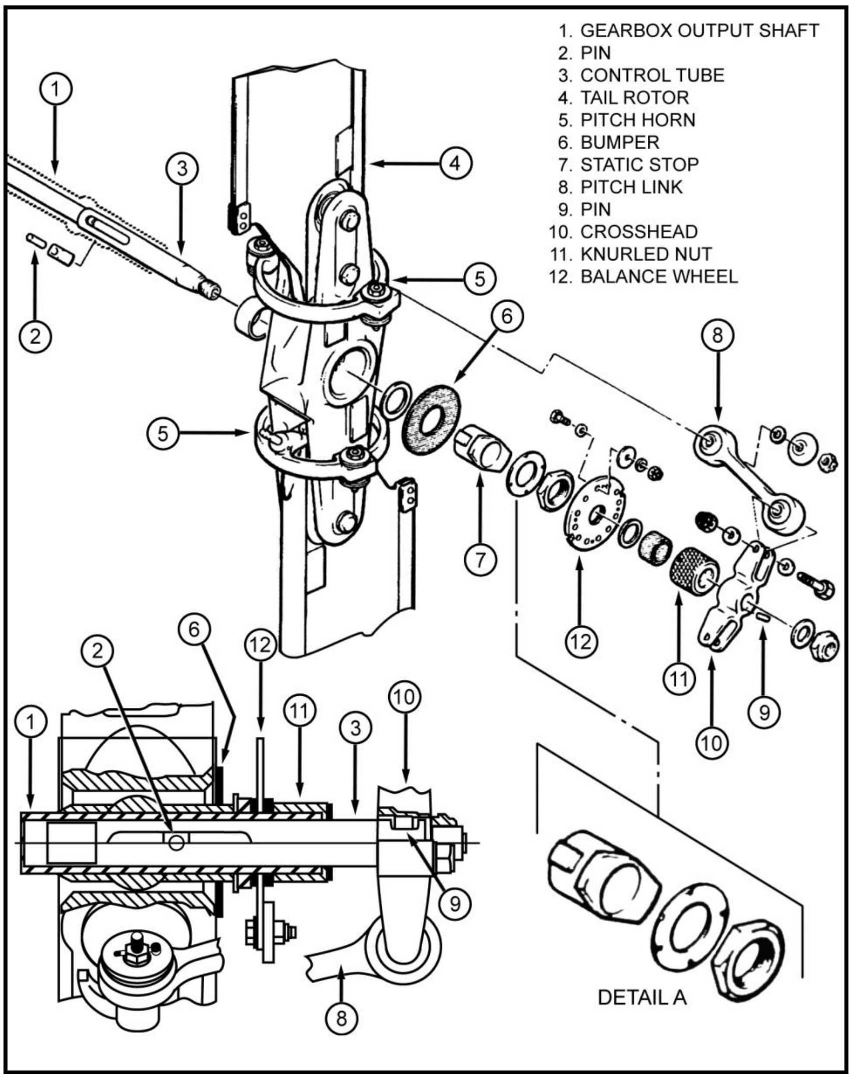

Figure 5-9 Tail Rotor Assembly

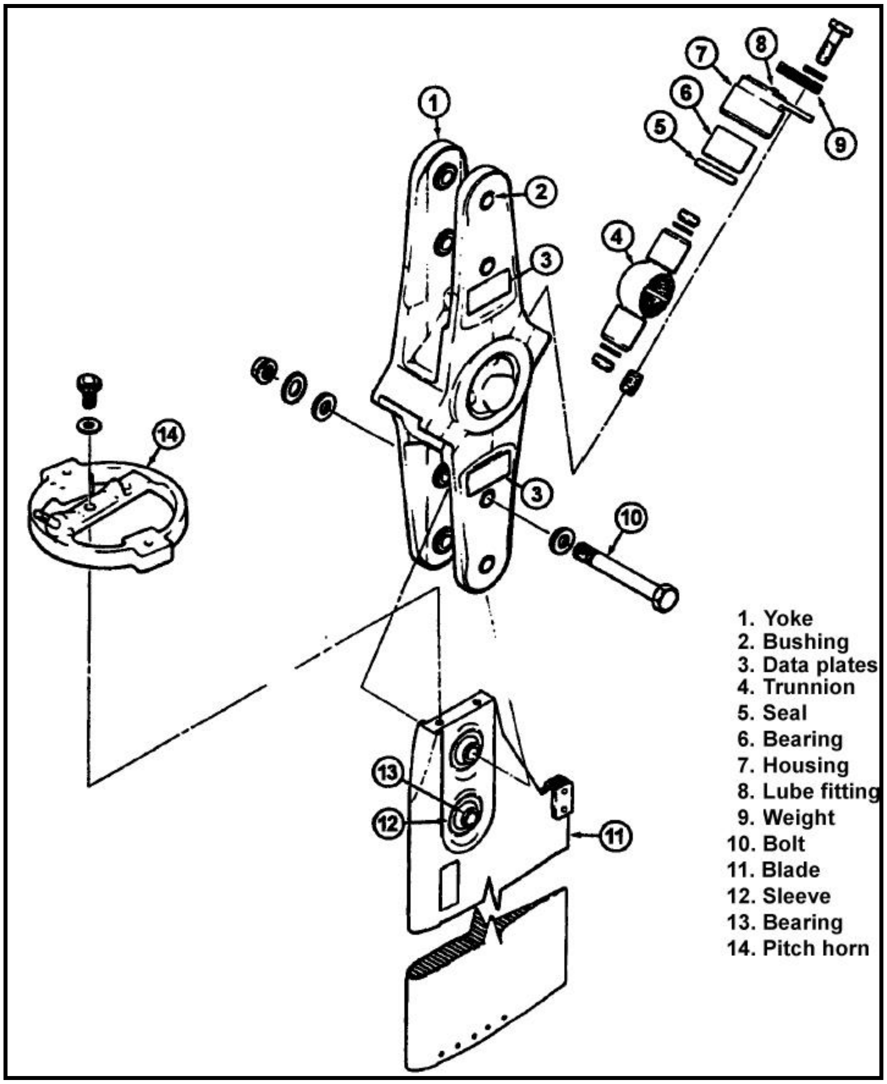

Figure 5-10 Yoke Assembly

The yoke assembly is made of forged aluminum alloy and is mounted to the gearbox shaft by a splined trunnion (Figure 5-10). Unlike the main rotor, the tail rotor is not underslung. ***Geometric balance is accomplished by an offset between the splined trunnion and the yoke assembly.*** Offset means that the trunnion is attached to the yoke assembly at an angle which is less than 90° to the span of the blades. When the tail rotor flaps, it does not move like a see-saw; instead, it flaps at an angle and the center of mass is maintained at the center of rotation.

503. THE TH-57 FLIGHT CONTROL SYSTEM

The TH-57 has a conventional type mechanical flight control system. There is a direct mechanical linkage consisting of aluminum alloy tubes from the pilot to both rotors. The three flight control systems are the ***cyclic, collective,*** and ***anti-torque pedals*** (Figure 5-11).

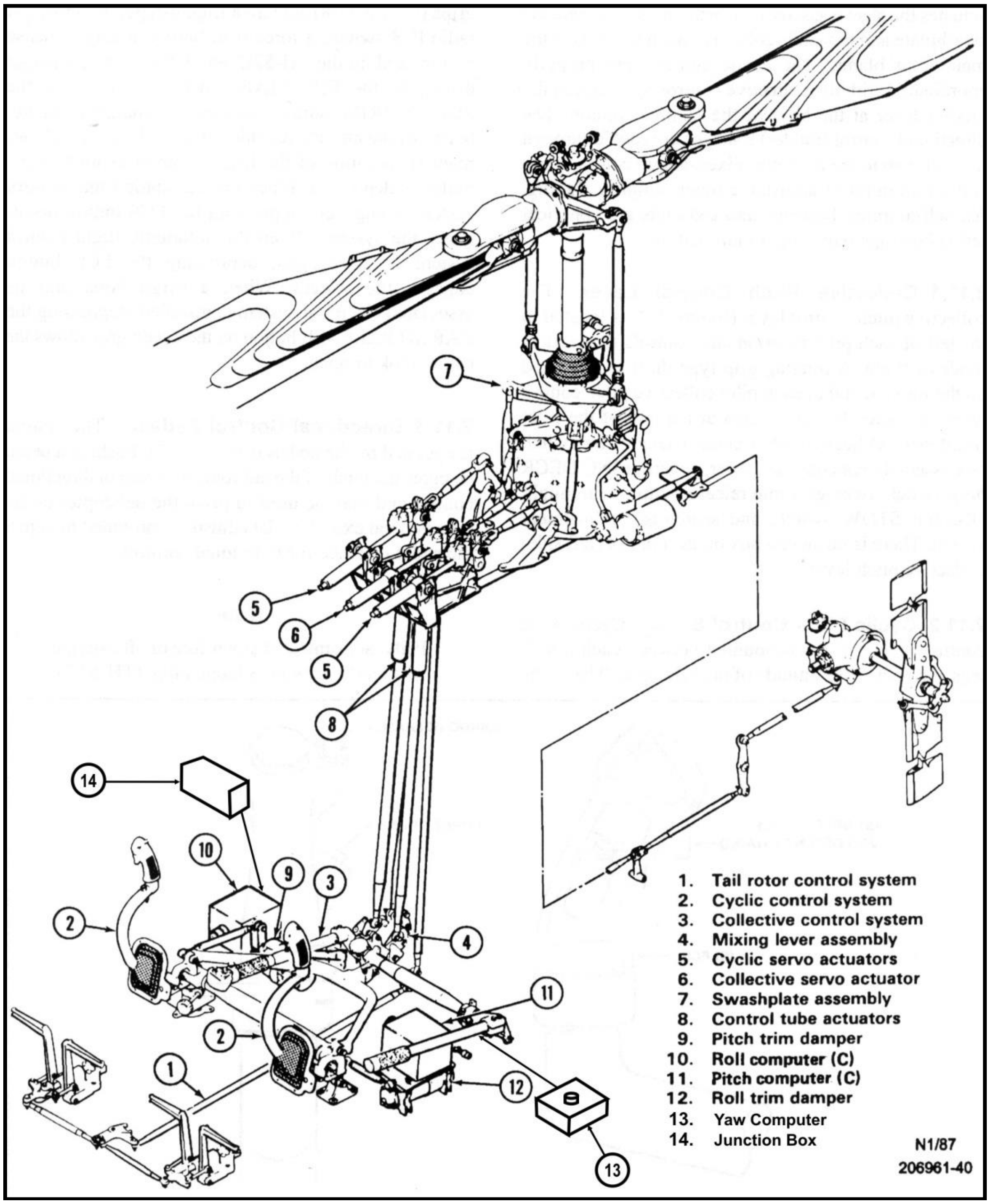

Figure 5-11 Flight Control System

1. **Cyclic Control**

A cyclic control input will result in the rotor disc tilting and the aircraft moving in the direction of the control input. The cyclic stick (Figure 5-12) is mounted on the pivot support, which allows the cyclic stick to move in a 360º direction (Figure 5-12, items 1 and 5).

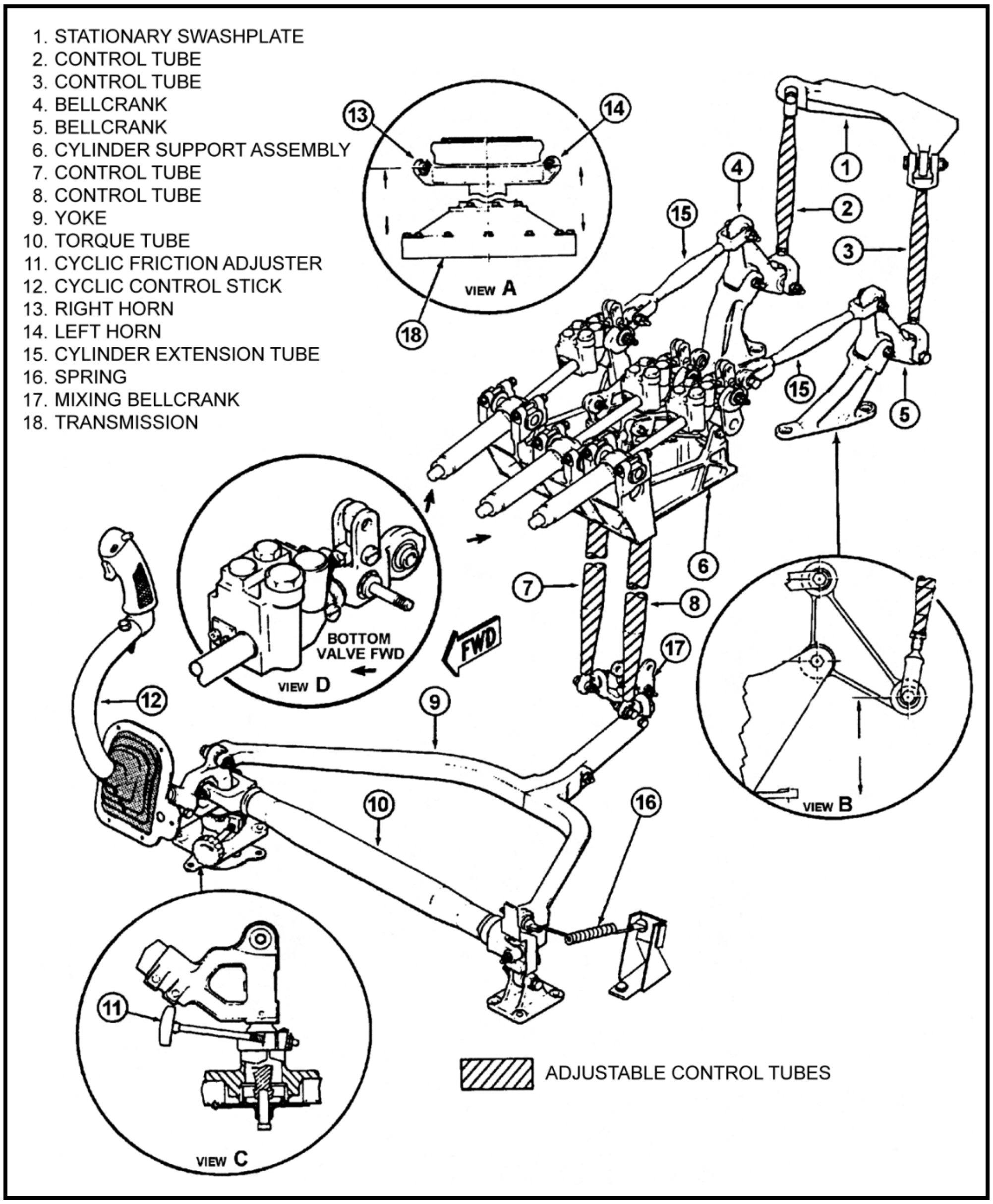

Figure 5-12 Cyclic Control

Also located at the base of the cyclic and part of the pivot support assembly is the friction adjuster. The friction adjuster allows the pilot to adjust the force required to move the cyclic stick. The pilot and copilot pivot supports are connected by a torque tube. The single yoke assembly transmits control inputs from the cyclic to the mixing lever. The mixing lever is located at the base of the control column. Fore-and-aft and lateral control inputs are intermixed by the mixing lever and transmitted up the control column to the hydraulic servos. Manual input is hydraulically boosted by the hydraulic servos and transmitted to the stationary swashplate by control tubes and bellcranks. ***The stationary swashplate takes control inputs from the cyclic and transmits them to the rotating controls.*** The rotating controls consist of the rotating swashplate, pitch change tubes, and pitch change horns.

The swashplate assembly consists of a stationary swashplate, rotating swashplate, pivot sleeve, swashplate support, and a drive link (Figure 5-13). The swashplate support is mounted to the top of the transmission and provides the mounting point for the pivot sleeve. The base of the pivot sleeve is the mounting point for the collective lever. The top of the pivot sleeve is of a uni-ball construction.

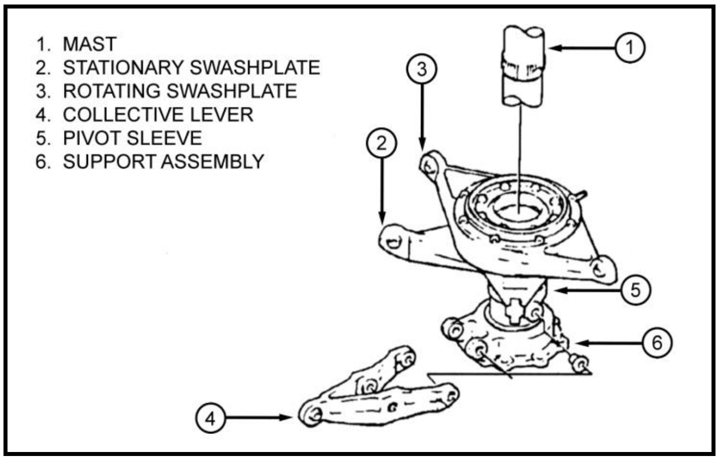

Figure 5-13 Swashplate Assembly

The uni-ball assembly is the mounting point for the stationary swashplate. ***The uni-ball is what allows the stationary swashplate to tilt in any direction.*** The rotating swashplate is mounted to the stationary swashplate by a set of bearings and bearing cap. Tilting the stationary swashplate will cause the rotating swashplate to tilt in the same direction. A drive link is spline mounted to the mast at one end and to the rotating swashplate at the other end.

The drive link lever and collar set will cause the rotating swashplate to rotate at the same speed as the rotor system. The rotating swashplate is connected to the rotor blade pitch horns by two pitch control tubes. Input from the cyclic stick will be transmitted to the pitch horns and cause a pitch angle change. Moving the cyclic stick forward will cause the stationary swashplate to tilt forward. The rotating swashplate will also tilt forward, since it is mounted to the stationary swashplate (Figure 5-15.)

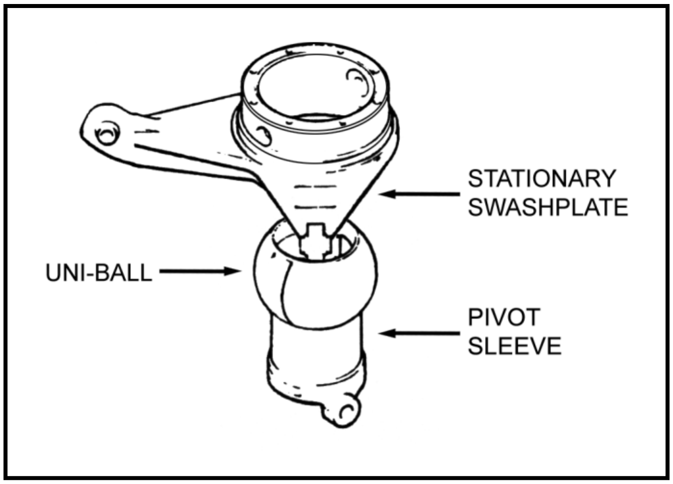

Figure 5-14 Uni-ball Assembly

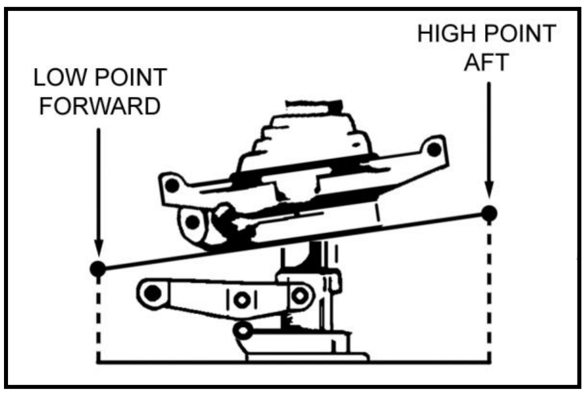

Figure 5-15 Swashplate Motion

A low point front and a high point rear is created when the swashplate is tilted forward. As the swashplate rotates, the pitch change tubes move up on the high side and down the low side. As a pitch change tub moves upward, blade pitch angle increases, and as it moves downward, blade pitch angle decreases. The retreating blade climbs and the advancing blade descends.

2. **Collective System**

The collective system acts independently of the cyclic is (Figure 5-16).

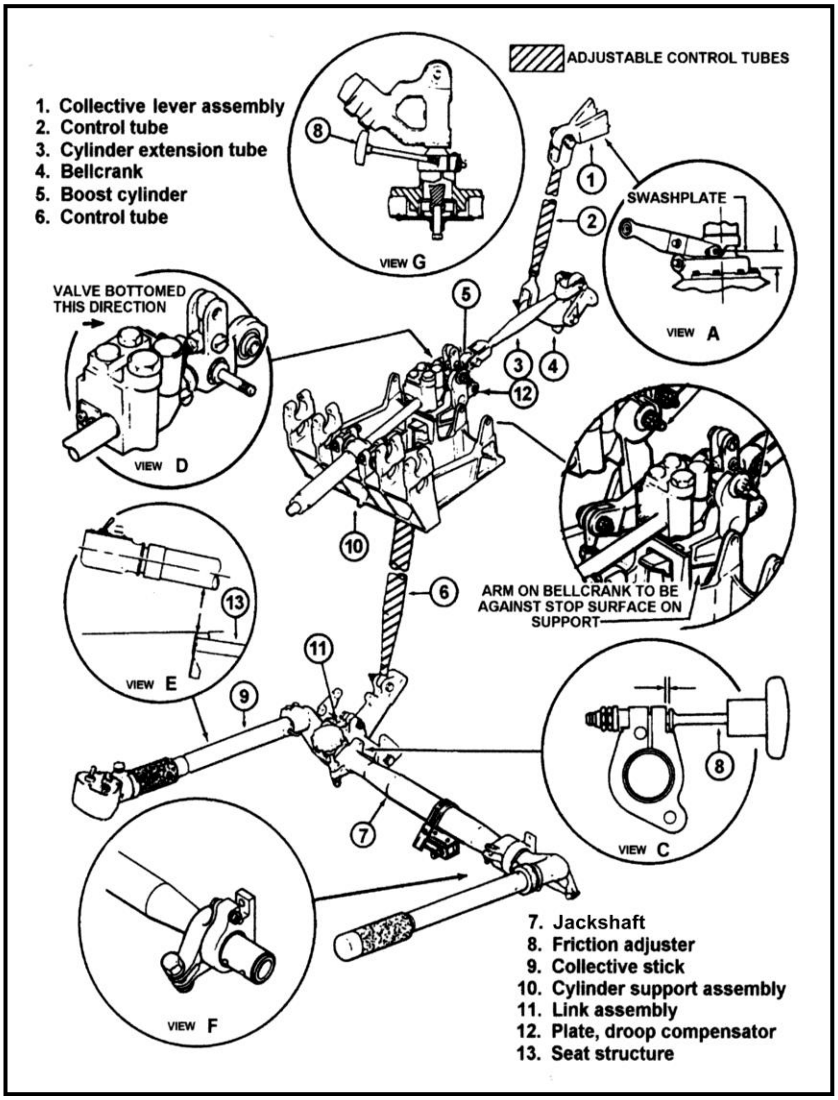

Figure 5-16 Collective Control

The collective stick through mechanical linkage transmits pilot inputs to the main rotor blades increasing or decreasing blade pitch angle equally and in the same direction. The collective stick located to the left of the pilot is mounted to a jackshaft. Also located at the jackshaft mounting point is a friction adjuster. The friction adjuster allows the pilot to adjust the amount of force required to move the collective. Collective inputs are transmitted through the mixing lever and control tube to the center hydraulic servo. From the servo, control tubes connect with the collective lever. Moving the collective stick upward will cause the collective lever to be pulled downward. A downward movement of the collective lever will raise the pivot sleeve and uni-ball assembly and thus raise the swashplate assembly (Figure 5-17.)

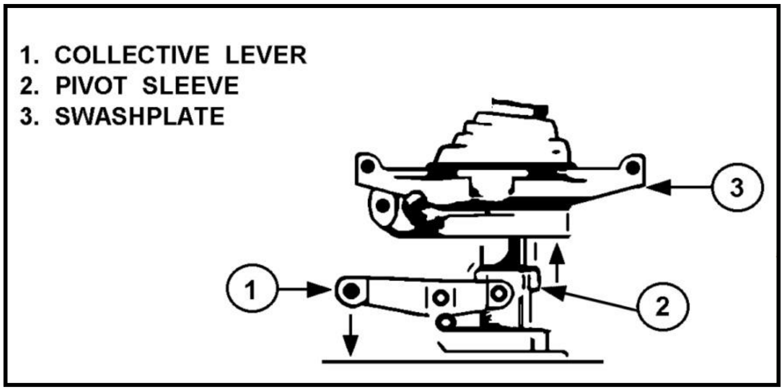

Figure 5-17 Swashplate Assembly

As the swashplate rises, the pitch angle of both rotor blades is increased equally.

3. **Anti-Torque Pedals**

Raising the collective will increase the torque effect and the TH-57, like all single rotor helicopters, must have a system to counter torque. The TH-57 uses a two-bladed, semirigid, flapping type tail rotor as an anti-torque device. Control of the tail rotor (Figure 5-18) is accomplished by control pedals, push-pull tubes, bellcranks, and a pitch change mechanism.

The control pedals, located on the cockpit deck, transmit control inputs by push-pull tubes to the tail rotor. Located with the control pedals is a starwheel adjuster. Rotation of the starwheel adjuster will move the pedals equally closer or farther from the pilot’s station. The control linkage, consisting of push-pull tubes, runs from the control pedals rearward up the control column through the tail boom to the pitch change mechanism. The pitch change mechanism mounted to the tail rotor gearbox consists of a lever, control tube, crosshead and pitch change links. The lever extends and retracts the control tube that runs through the tail rotor gearbox and drive shaft.

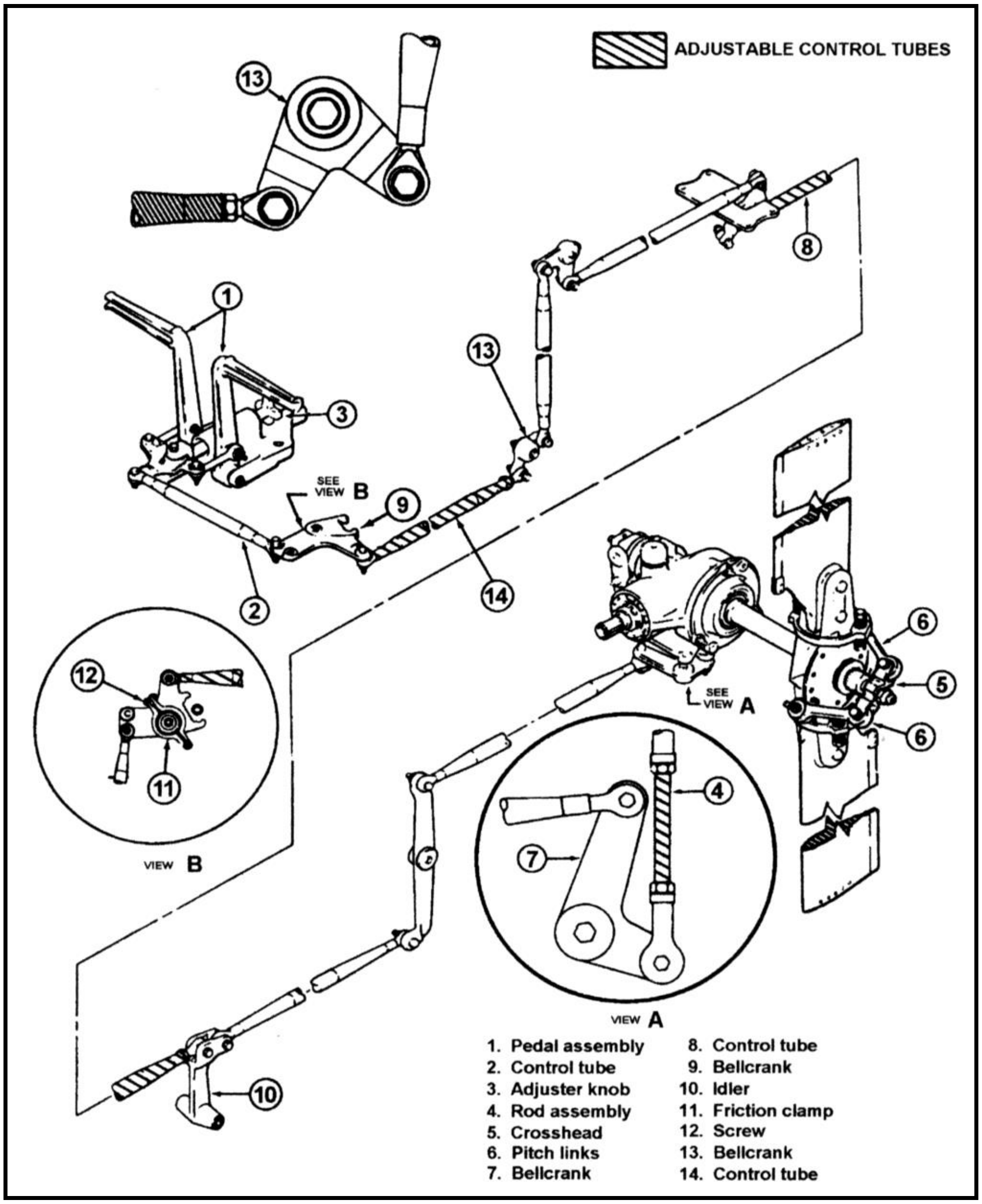

Figure 5-18 Tail Rotor Controls

As the crosshead is attached to the control tube, the crosshead moves in and out. The crosshead moving in and out will change the pitch angle of the tail rotor blades via the pitch change link and pitch horns (Figure 5-18). When left pedal is applied, control tubes are moved and the lever assembly retracts the control tube. As the control tube retracts, the crosshead moves closer to the yoke assembly and tail rotor blade pitch is increased.

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CHAPTER FIVE REVIEW QUESTIONS

1. The main rotor is a _____, _____type rotor system.

2. The _______ _______ provides the mounting point for the yoke assembly.

3. State the component that provides the flapping axis for the main rotor.

4. Underslinging keeps the main rotor system aerodynamically balanced during flapping or tilting of the rotor system.

   a. True b False

5. How much preconing is built into the yoke?

6. Preconing _____ _____ _____ of the yoke, blade grips, and the root end of the rotor blade.

7. Identify the component that absorbs centrifugal forces and will twist to allow for pitch change action.

8. The predominant metal used in the main rotor blades is __________.

9. The vertical through bolt that secures the main rotor blade is hollow.

   a. True b. False

10. Weights are added at the tip and midspan of each main blade for auto-rotational flight.

    a. True b. False

11. Each main rotor blade weighs approximately _______ pounds.

12. Main rotor blade chord length is ______.

13. The main rotor system utilizes a _____ _____ _____ to prevent excessive flapping.

14. The flap restraint kit is a _____ and _____ _____ assembly.

15. In powered flight, the fuselage attempts to rotate _____.

16. The effects of main rotor torque are offset by the _____ _____.

17. The tail rotor system, like the main rotor system, is a semirigid, flapping type system.

    a. True b. False

18. How is tail rotor blade strength increased?

19. Spanwise balance of the tail rotor blades is accomplished with ____________ on the blade bolts.

20. Chordwise balance of the tail rotor blades is accomplished with weights and washers on the trunnion bearing housing retaining bolts.

a. True b. False

21. Pitch angles of the tail rotor blades are changed with the _____________ ______ via the pitch change links.

22. Dynamic balancing of the tail rotor system is accomplished using the _____ _____.

23. Tail rotor flapping is limited by the _____ _____.

24. Like the main rotor, the tail rotor achieves underslinging with pillow blocks.

a. True b. False

25. The TH-57 flight control system is a _____ system.

26. Name the three flight control systems.

27. The main rotor disc tilts with a _____ control input.

28. Manual inputs to the cyclic system are pneumatically boosted.

a. True b. False

29. Cyclic inputs are transmitted via the _____ to the rotating controls.

30. Name the component that allows the stationary swashplate to tilt in any direction.

31. Blade pitch angle is increased or decreased equally with a collective input.

a. True b. False

32. Tail rotor blade pitch decreases with ______ pedal input.

33. The TH-57C rotor brake assembly receives 600 psi hydraulic fluid from the aircraft hydraulic system.

a. True b. False

34. The direct reading type gauge associated with the rotor brake is located

a. on the instrument panel.
b. adjacent to the power pack.
c. overhead between the pilots.
d. on the center console.

CHAPTER FIVE REVIEW ANSWERS

1. Semirigid…flapping
2. Splined trunnion
3. Splined trunnion
4. a
5. 2 1/4°
6. Relieves bending stress
7. Tension torsion strap
8. Aluminum alloy
9. a
10. a
11. 94
12. 13 inches
13. Flap restraint kit
14. Flyweight…spring type
15. Clockwise
16. Tail rotor
17. a
18. Stainless steel doublers
19. Washers
20. a
21. Pitch change horn
22. Balance wheel

23. Static stop
24. b
25. Conventional
26. Cyclic…Collective…Anti-torque pedals
27. Cyclic
28. b
29. Stationary switchplate
30. Uni-ball
31. a
32. Right
33. b
34. c

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CHAPTER SIX
HYDRAULIC SYSTEM

600. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will state the need for a hydraulic system and identify the major components along with their associated parts, functions and limitations, and their relationship.

601. ENABLING OBJECTIVES

1. State the basic purpose of the TH-57 hydraulic system and identify which control systems receive hydraulic assistance.

2. State the major components of the hydraulic system and their functions.

   a. Identify the components of the power pack and their functions.

      - State the capacity and pressure requirements of the system.

   b. Identify the components of the filter and their functions.

      - State the primary indication of filter stoppage and the corrective action.

   c. Identify the function of the pressure switch.

      - State how the hydraulic pressure light operates with the pressure switch.

   d. Identify the function(s) of the solenoid.

      i. Describe the operation of the solenoid valve relative to the hydraulic switch.

      ii. State how the hydraulic switch circuit is protected.

   e. Name the three major servo valves and state their functions.

      i. State how a fluid return port is established.

      ii. Describe how the system dampens main rotor feedback.

      iii. State the result of excessive system back pressure.

      iv. State how flight controls receive hydraulic boost.

      v. State how the actuator works when the hydraulic pressure is lost.

602. TH-57B/C HYDRAULIC SYSTEM

The hydraulic system (Figure 6-1*) consists mainly of a power pack, filter, pressure switch, solenoid valve and servos.* This highly efficient system reduces pilot workloads by reducing control pressures and vibrations generated by the main rotor system. Since the main rotor is where the heavy control loads exist, hydraulic assisted control is provided only for the cyclic and collective control systems. Our discussion will deal with the major components mentioned above and will begin with the power pack.

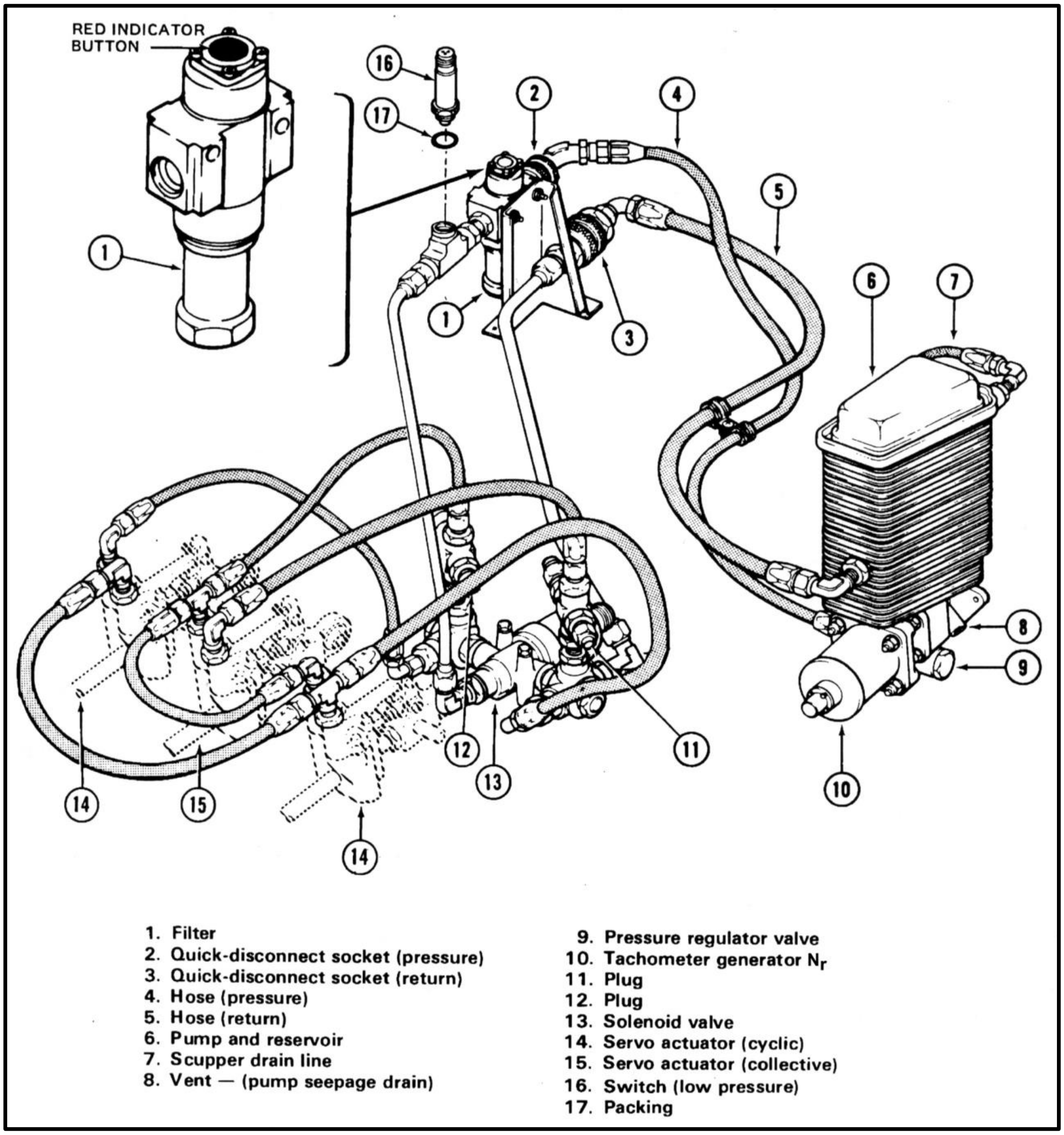

Figure 6-1 Hydraulic System

1. **Power Pack**

The power pack is located on the forward port side of the transmission and is driven by the transmission accessory drive shaft. ***The power pack consists of the reservoir area, pump section, pressure regulator valve and rotor tachometer generator mounting pad*** (Figure 6-2). Because the system generates heat, the reservoir is finned and has air directed from the engine oil cooler blower to aid in cooling. The capacity of the reservoir is approximately one pint and it has a scupper and drain line to drain vented fluid overboard. Fluid level is checked through a sight gauge on the right side of the reservoir. Hydraulic fluid is gravity fed from the reservoir to the pump assembly, which pressurizes the fluid and sends it through the pressure regulator valve. This valve regulates system pressure to approximately 600 ± 50 psi. Next, the fluid is pumped to the hydraulic filter.

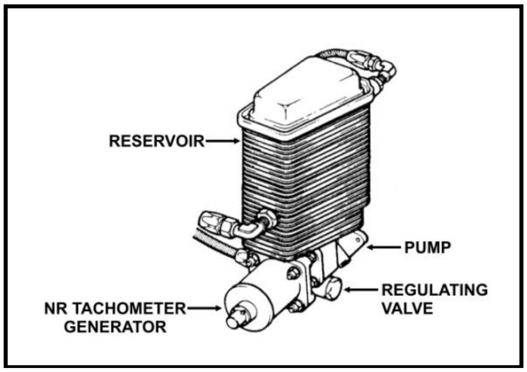

Figure 6-2 Power Pack

2. **Hydraulic Filter**

The purpose of the filter is to remove foreign matter that has contaminated the hydraulic fluid. The hydraulic filter assembly (Figure 6-3) consists of a head, filter element, and body. ***Since there is no bypass system, unfiltered fluid cannot enter the servos if the filter becomes clogged. A popped filter indicator means filter stoppage and the filter element should be cleaned or replaced by maintenance before flight.***

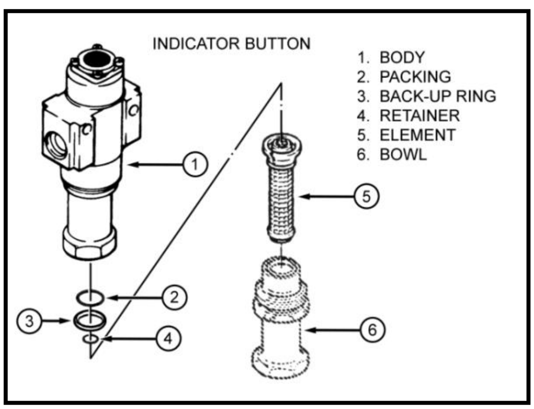

Figure 6-3 Hydraulic Filter Assembly

3. Hydraulic Pressure Switch

The hydraulic pressure switch (Figure 6-4) is located downstream from the filter. ***This switch continually monitors system pressure and will close if the pressure falls below 300 psi. A hydraulic pressure light illuminates when the switch closes and goes out when the pressure rises above 400 psi.***

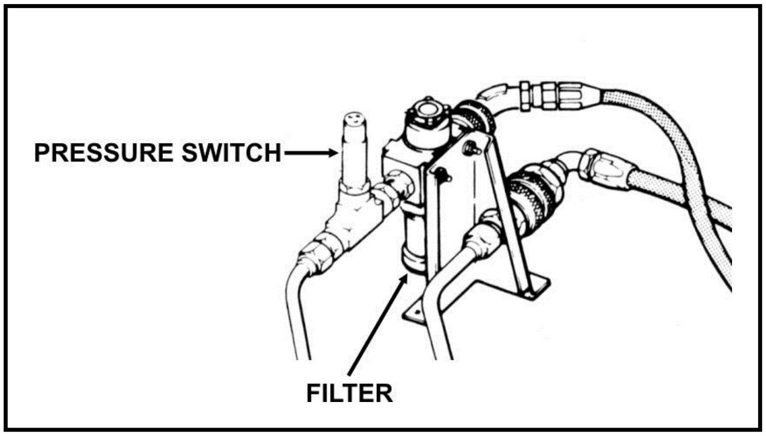

Figure 6-4 Hydraulic Pressure Switch

4. Solenoid Valve

The next component in the system is the hydraulic solenoid valve, located on the service deck forward of the transmission. ***The valve is spring-loaded to the open position and requires electrical power to the solenoid to move the valve to the bypass position.*** This ***fail-safe*** design feature ensures the valve is open at all times, unless bypass is selected. The hydraulic ON/OFF switch (Figure 6-5), located on the pedestal (TH-57B) or near the center of the instrument panel (TH-57C), controls the solenoid valve. With the hydraulic control switch ON, no power is applied to the solenoid valve and it springs to the open position. With a hydraulic system failure, such as a servo malfunction, setting the switch to OFF will supply electrical power to the solenoid valve to move it to the bypass position. This action removes pressure from the servos and terminates hydraulic boost to the flight controls.

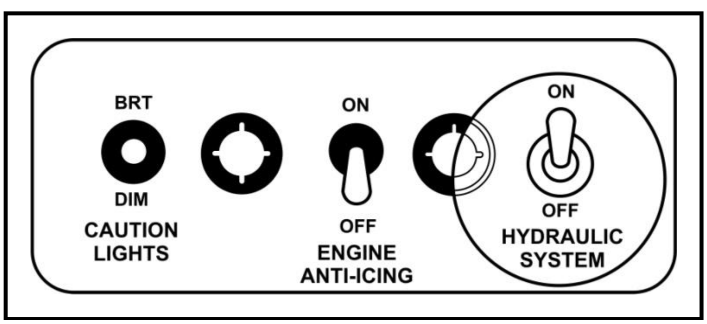

Figure 6-5 Hydraulic ON/OFF Control Switch

Circuit protection is provided by the hydraulic boost circuit breaker located on the overhead console. With the valve in the open (ON) position, hydraulic fluid is routed to the three servos (Figure 6-6).

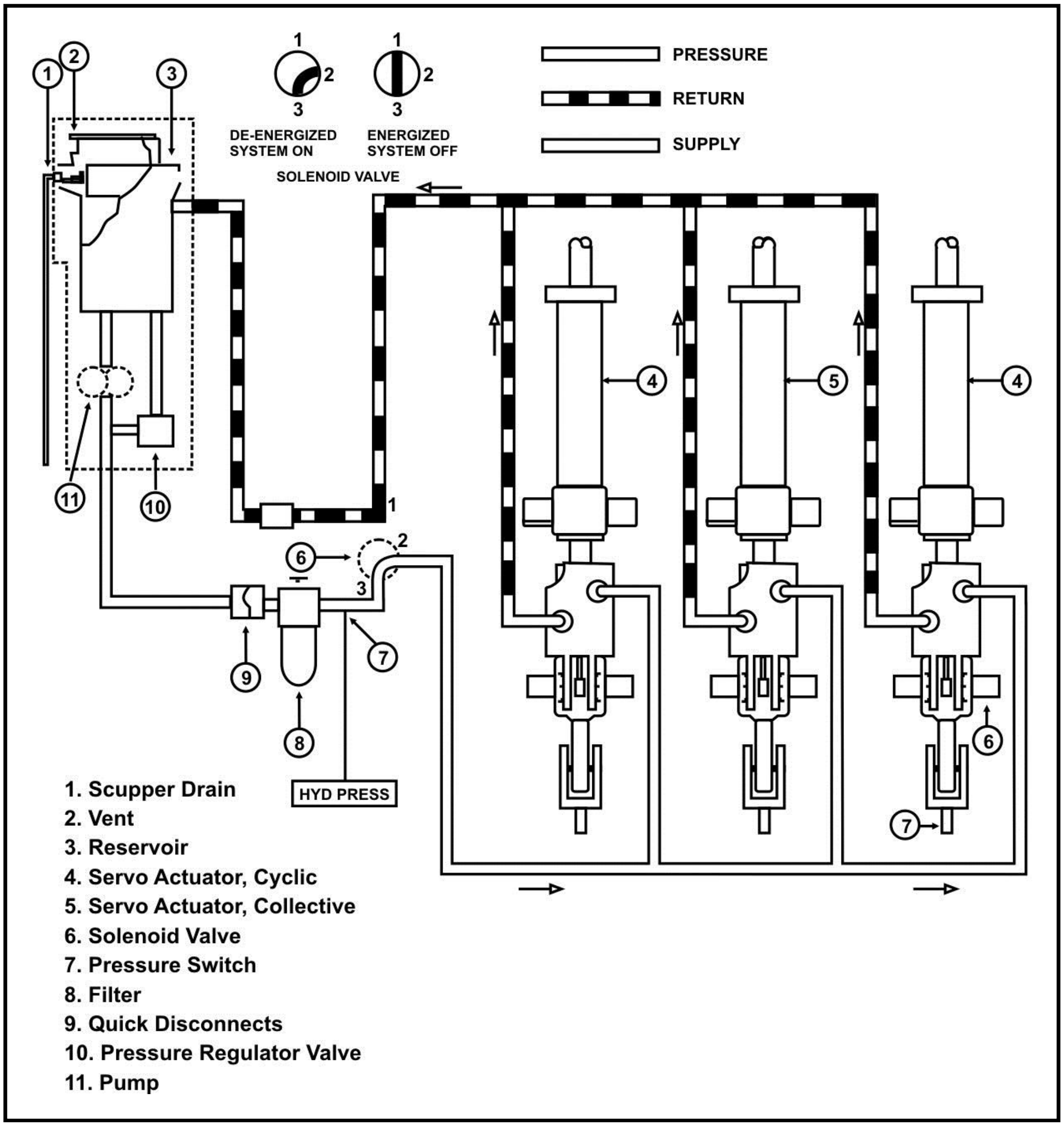

Figure 6-6 Hydraulic System Schematic

5. **Servo Actuators**

The major servo actuator components are the sequence valve, pilot valve, and differential relief valve (Figure 6-7).

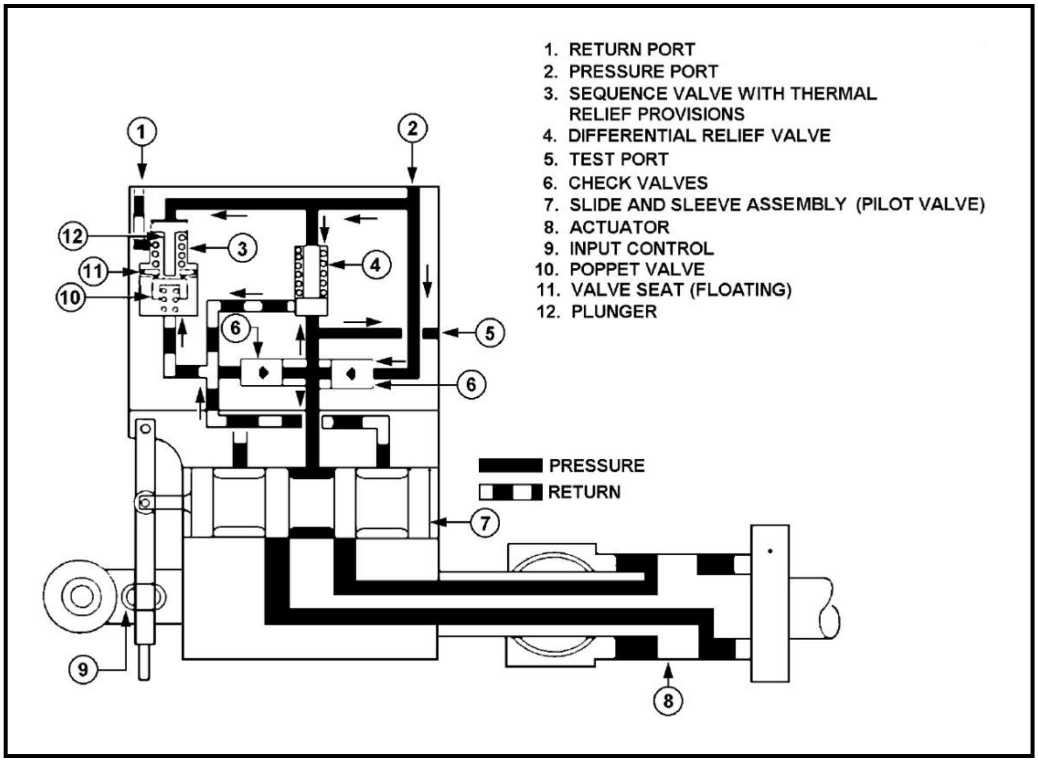

Figure 6-7 Servo Actuator Diagram

With the system operating, fluid at 600 psi enters the servo pressure port and the flow is stopped until a control input is made. Hydraulic pressure on the sequence valve pushes down on the poppet valve and spring, thereby opening a return port for fluid to return to the reservoir. If pressure is lost, the sequence valve closes, trapping fluid in the servo which will continue to dampen main rotor feedback (vibrations). The function of the differential relief valve is to cause fluid to be routed to the return line if back pressure exceeds system pressure. Heavy main rotor loads are one possible source of excessive back pressure. The heart of the servo is the pilot valve. The pilot valve is mechanically connected to the flight controls and receives input from movement of the controls. This causes the pilot valve to move and allow fluid under 600 psi pressure to enter the actuator, which then moves the flight controls. When the flight controls reach the desired position, the pilot valve centers and fluid flow to the actuator is stopped. Again, in the event pressure is lost, the sequence valve will trap fluid in the servo. In this case, movement of the pilot valve will allow fluid to flow from one side of the actuator through the valve body to the other side of the actuator. This allows control movement and dampens rotor system vibrations felt through the controls. Under normal pressurized operation, the fluid is routed from the servo back to the reservoir, where it is cooled and the cycle repeated.

603. FORCE TRIM SYSTEM

The hydraulic system eliminates all control pressures to the cyclic. To counter this effect, a force trim system has been added to the cyclic control. The force trim system (Figure 6-8) incorporates a DC powered electromagnetic brake and a force gradient spring in the cyclic control system to provide artificial feel.

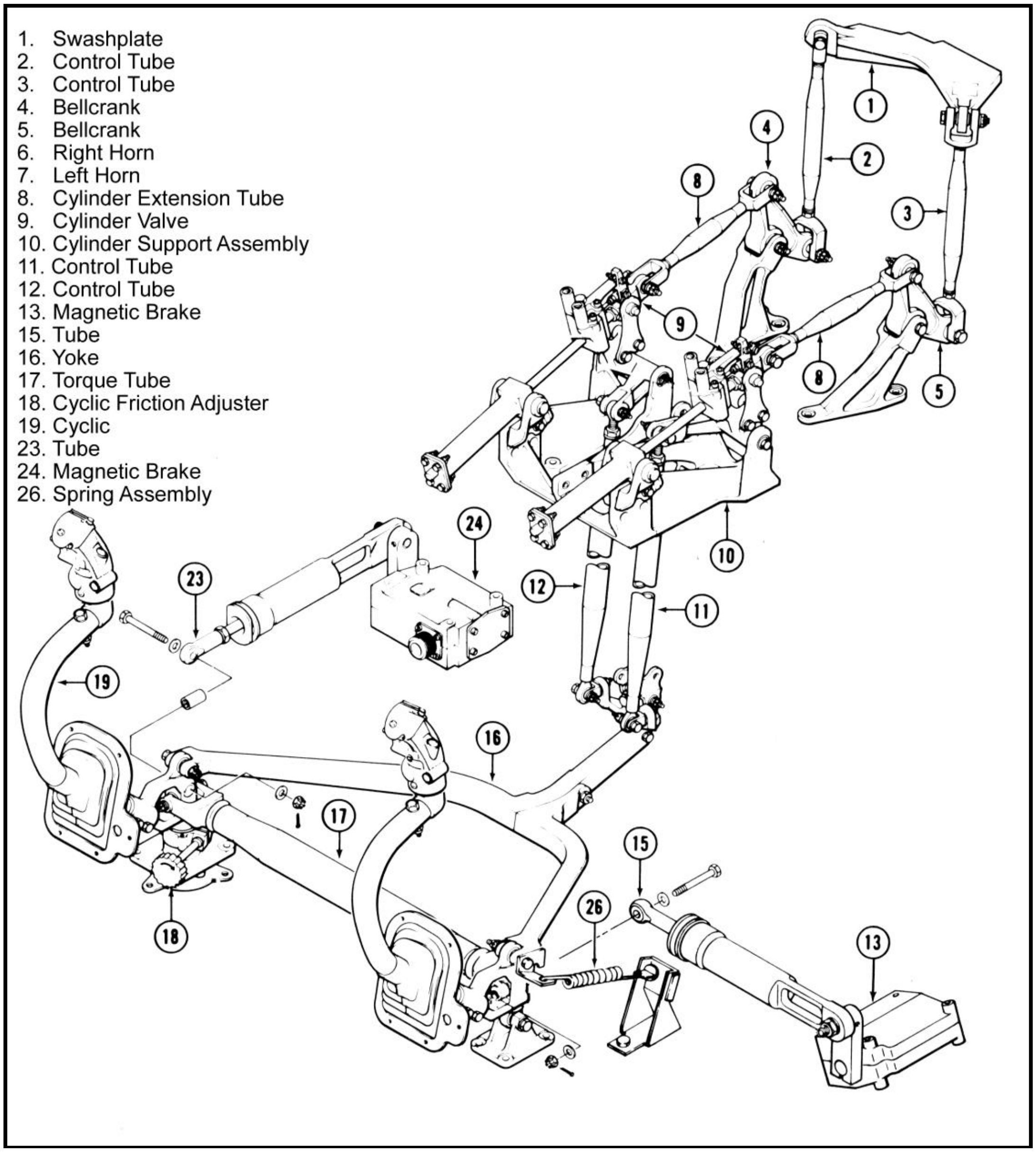

Figure 6-8 Force Trim

Depressing the cyclic force trim button (Figure 6-9) will release the magnetic brake and allow the force gradient spring to be repositioned to correspond to the position of the cyclic stick, thus providing cyclic position trim.

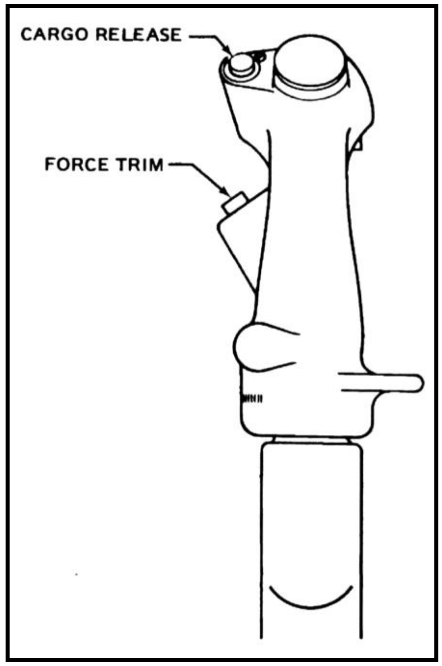

Figure 6-9 Cyclic Grip

CHAPTER SIX REVIEW QUESTIONS

1. Match the following hydraulic subsystems in column one with their associated components in column two.

a.	___ Pilot Valve	1.	Servo
b.	___ Differential Relief Valve	2.	Power Pack
c.	___ Pressure Regulator Valve		
d.	___ N_r Tach Generator Mounting Pad		
e.	___ Sequence Valve		
f.	___ Pump Section		
g.	___ Reservoir		

2. The tail rotor system receives hydraulic assistance.

   a. True b. False

3. How is the hydraulic fluid level checked?

   a. Check the maintenance forms.
   b. Ask the plane captain.
   c. Check the reservoir sight gauge.
   d. Check the quantity gauge on the console.

4. The pressure regulator valve regulates system pressure at ___ psi.

   a. 300 c. 500
   b. 400 d. 600

5. If the filter clogs, the hydraulic bypass system will allow fluid to enter the servos.

   a. True b. False

6. List the five components of the hydraulic system.

   1. 4.
   2. 5.
   3.

7. A popped _____ indicator indicates a clogged filter element.

8. The hydraulic system pressure caution light illuminates when system pressure falls below

   a. 600 psi. c. 400 psi.
   b. 500 psi. d. 300 psi.

9. Setting the hydraulic ON/OFF switch to the OFF position causes the solenoid valve to move to the bypass position.

a. True b. False

10. If hydraulic pressure is lost, which component of the servo will trap fluid in the servo?

a. Differential relief valve
b. Sequence valve
c. Pressure regulator valve
d. Pilot valve

11. The cyclic force trim system provides _____ _____ and _____ _____.

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CHAPTER SIX REVIEW ANSWERS

1.
    - a. 1
    - b. 1
    - c. 2
    - d. 2
    - e. 1
    - f. 2
    - g. 2

2. b

3. c

4. d

5. b

6.
    1. Power pack
    2. Pressure switch
    3 Servos
    4. Filter
    5. Solenoid valve

7. Filter

8. d

9. a

10. b

11. Artificial feel…cyclic trim

CHAPTER SEVEN
ENVIRONMENTAL CONTROL SYSTEM

700. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will identify characteristics of the Environmental Control System (ECS) and the operation of various knobs, switches, and subsystems that control airflow, cooling, and heating inside the cockpit.

701. ENABLING OBJECTIVES

1. Identify the functions of the ventilation and defog systems and state how their associated components work to provide ram air ventilation and defogging.

2. Identify the major components of the vapor cycle air conditioner and state how they work independently and together to provide cabin air cooling.

3. Identify the major components of the bleed air heater system in the New B and C, and state how these components warm the cabin air.

4. Identify the operational procedures associated with monitoring system temperatures.

702. ENVIRONMENTAL CONTROL SYSTEM

The four subsystems comprising the ECS are:

1. Ram air ventilation

2. Defog system

3. Air conditioner

4. Bleed air heater

Ram air ventilation and defog system. The TH-57 is equipped with a ventilation and defog system to ensure the windscreen remains clear and to provide ambient air through the cabin for crew ventilation. The ventilation and defog system consists of five major components to supply ambient air to the windscreen and cockpit (Figures 7-1 & 7-2).

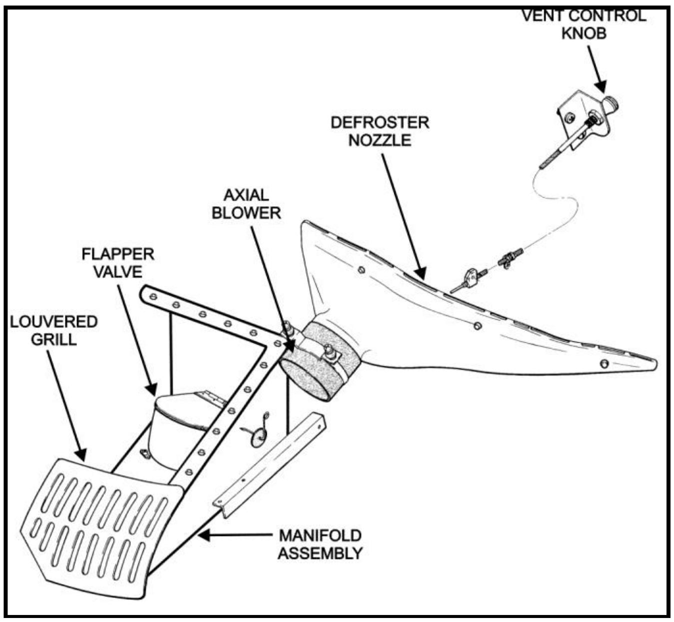

Figure 7-1 Ram Air Ventilation

Figure 7-2 shows the location of the two louvered grills that allow ram air to reach the ventilating system. These grills are located on either side of the battery access door. Also depicted are the sliding windows in the crew and passenger doors that provide additional ventilation.

Air entering through the grill enters a manifold assembly (Figure 7-2) which directs air to the cabin and the defog system. The amount of ventilating air entering the cabin is controlled by two pushpull cable controls located on either side of the center console. These vent controls, mechanically connected to the flapper valves, will lock in different positions to vary the amount of air entering the cabin. The flapper valves also divert air to the defog system when the vent control knobs are pulled out. Two electrically driven axial flow blowers are installed in the inlet end of the defroster nozzles. The axial blowers maintain a continuous flow of air, depending on the cockpit setting. The blowers are controlled by the “DEFOG BLOWER” circuit breaker type switch located on the forward end of the overhead console. The defroster nozzle is installed in the base of the windscreen to evenly distribute defog air on the interior. The defog system is primarily used for ventilation and defogging during ground operation of the helicopter. Although not dependent on ram air for defog operations, airflow will be increased when both vent control knobs are pulled full out. Furthermore, the defog system works best when operated in conjunction with the air conditioner or heater system. To operate, turn the air conditioner or heat switch on as required. Then turn the defog blower on, select high or low fan speed and open the air conditioner or heater outlets. When the defog system is used in conjunction with the air conditioner or heater, close the ram air vents.

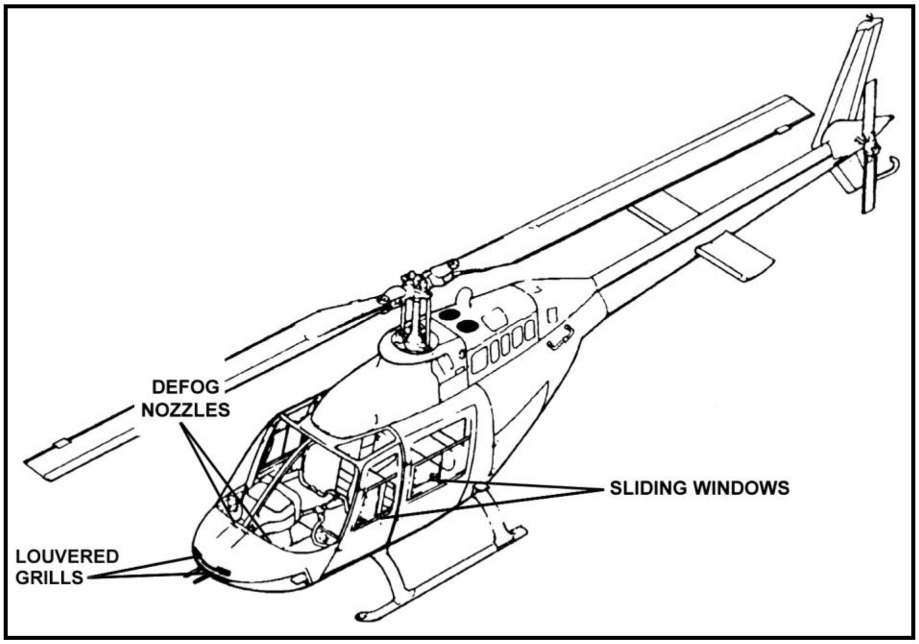

Figure 7-2 Louvered Grills

Vapor Cycle Air Conditioner. The vapor type air conditioning used for cabin cooling requires approximately 5 horsepower to operate (Figure 7-3). This system is made up of the following major components:

1. Switch panel

2. Compressor

3. Condenser

4. Condenser blower

5. Evaporator

6. Evaporator blower

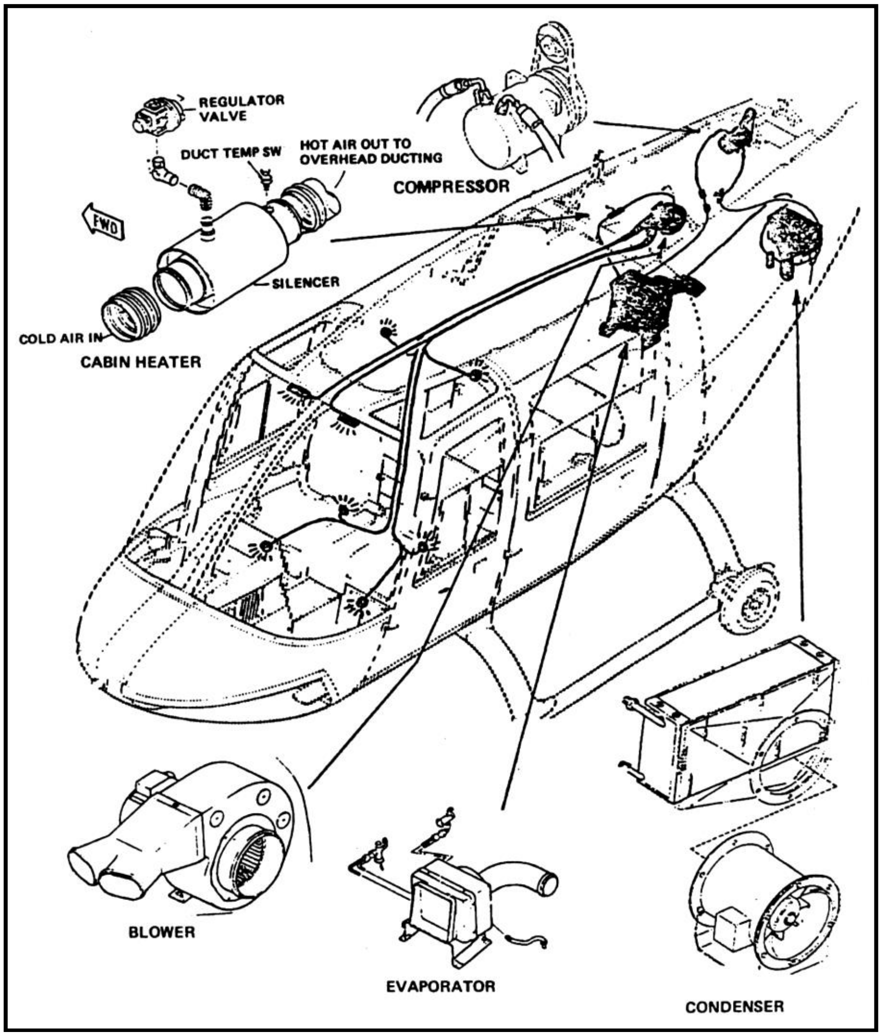

Figure 7-3 ECS Layout

Switch Panel. The switch panel (Figure 7-4) is located on the instrument subpanel on the center console. The switch panel contains the following switches:

1. Air Cond/OFF/Fan Switch
2. Fan Speed Switch
3. Temperature Regulator Switch

AIR COND or FAN may be selected. In the AIR COND mode, the compressor, condenser fan, evaporator fan, and forward blowers are automatically activated, distributing cold air. The FAN mode operates the forward blowers and evaporator fan and permits cabin air circulation only, either in a HI or LO blower speed as selected by the second switch. Temperature control is accomplished through a rotary type cooling switch connected to a thermostatic relay that cycles the compressor on and off, based on the temperature selected.

Figure 7-4 Air Conditioner Switch Panel

Compressor and Condenser Assembly. Selecting the AIR COND position closes the compressor relay, which allows a power circuit to be completed through a temperature control relay to the compressor. Figure 7-5 shows the location of the compressor and the condenser/blower assembly. The compressor is driven by a pulley and belt arrangement off of the tail rotor drive shaft. When the electrical circuit to the compressor is completed, an electrical clutch engages and the compressor begins to pump freon gas from the evaporator. The compressor compresses the gas to a high pressure and temperature and then routes it to the condenser located behind the baggage compartment just aft of the access panel. The pressurized freon gas flows through the condenser coils and condenses to a liquid when cooled by the condenser fan blowing air over the coils. The liquid freon is then stored under pressure in the receiver dryer located next to the evaporator. The receiver dryer stores the liquid freon for on-demand use of the evaporator.

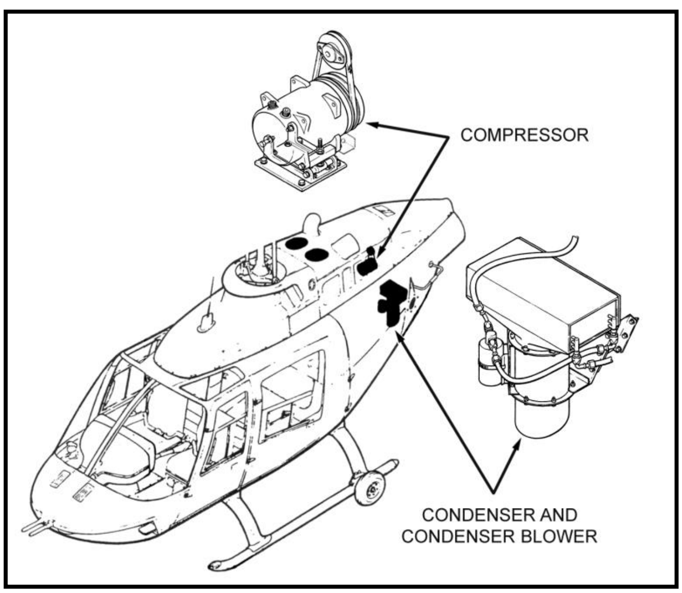

Figure 7-5 Location of Compressor and Condenser Assembly

Evaporator and Evaporator Blower. The evaporator (Figure 7-6) is located in the electrical compartment on the left side of the aircraft. Flow of freon to the evaporator is controlled by two thermostatically controlled expansion valves. The expansion valves work on temperature and pressure. With the compressor operating, a low pressure is created from the evaporator to the compressor, and the expansion valves open. The expansion valves will meter the liquid through the evaporator at a rate so it will be a gas by the time it reaches the compressor. As the liquid passes through the expansion valves and enters the low pressure evaporator, it reverts back to a gas. In the process of turning from a liquid to a gas, the gas absorbs heat. At the same time the gas is absorbing heat and cooling the evaporator coils, the evaporator fan is pulling cabin air through the coils and returning cool air back to the cabin. The evaporator blower is located on the right side of the fuselage above the baggage compartment.

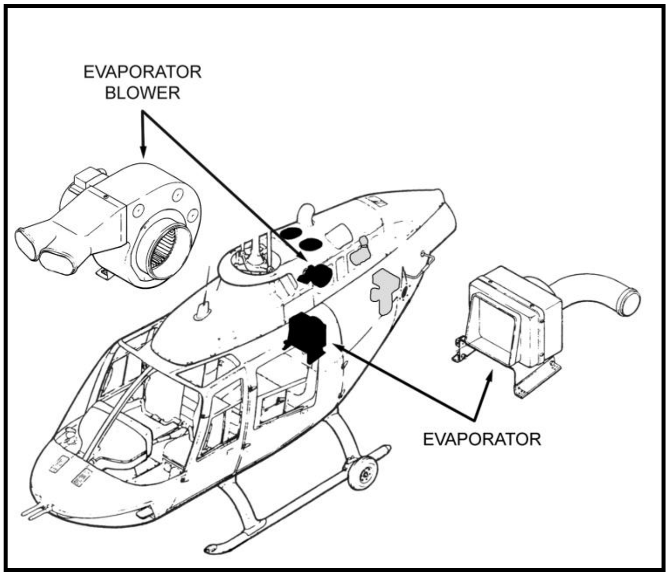

Figure 7-6 Location of Evaporator and Evaporator Blower

Bleed Air Heater. Vapor cycle air conditioning will not heat, so your TH-57 requires a separate heating system. A bleed air heater (Figure 7-7) has been installed in-line between the evaporator and the evaporator fan. The bleed air heater system consists of the following components:

1. Heater silencer

2. Control valve

3. Regulator valve

The heater silencer (Figure 7-7) is located just above the baggage compartment and is where bleed air is mixed with cabin air.

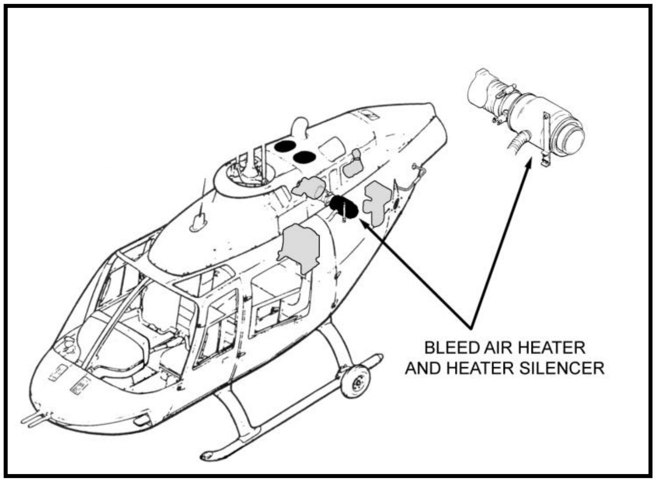

Figure 7-7 Location of Bleed Air Heater

Figure 7-8 provides a more in-depth look at the heater system. The inlet side is connected to the ventilation ducting coming from the evaporator and the outlet is connected by ventilation ducting to the evaporator blower. The amount of bleed air mixing with cabin air is effected by the position of the control valve located on the overhead console. The control valve rotates from OFF (full clockwise) to a maximum heat position (full counterclockwise) and governs a control airflow to the regulator valve. As the control valve is moved counterclockwise, controlled airflow will cause the regulator valve to open, which allows a proportional amount of engine bleed air to enter the heater silencer. Bleed air entering the heater silencer mixes with cabin air and is then circulated by the evaporator fan. This will occur even if the AIR COND mode is selected on the air conditioner switch panel. Also located in the heater silencer is a duct temperature switch. The duct temperature switch monitors the air temperature in the outlet side of the heater silencer. When the duct temperature switch is activated, a light on the instrument annunciator panel labeled “Duct Hi Temp” will illuminate. In the event the “Duct Hi Temp” light illuminates, you should place the environmental control switch to FAN and fan speed switch to the HI position. An important area to monitor when operating the bleed air heater is –TOT. Any time the heater is operated, you must monitor turbine outlet temperature in order to ensure TOT limitations are not exceeded.

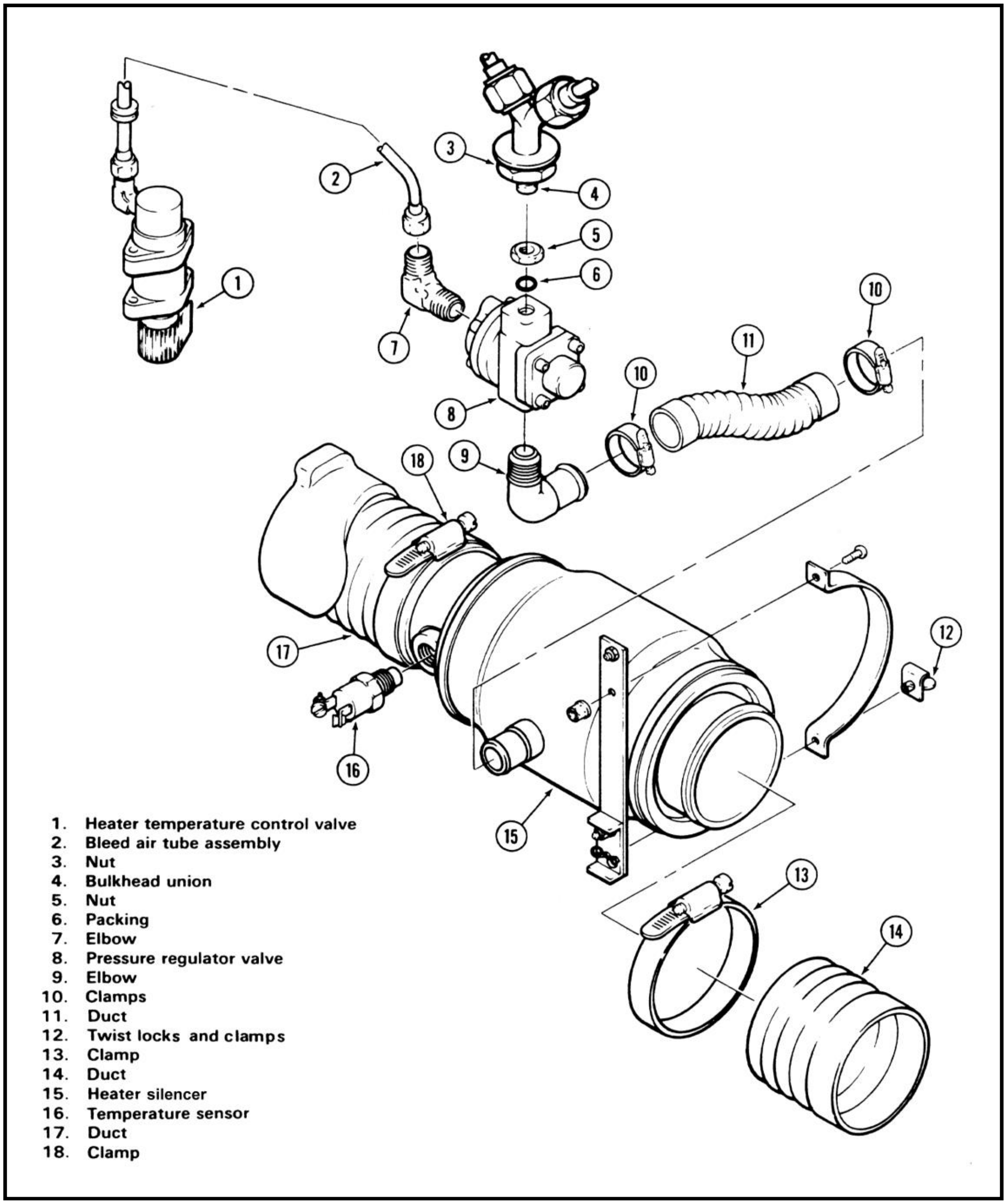

Figure 7-8 Major Components of Heater System

CHAPTER SEVEN REVIEW QUESTIONS

1. Major components of the Environmental Control System include ram air ventilation, bleed air heater, air conditioner, and the

a. blower fans.	c. filter.
b. defog system.	d. switch panel.

2. The defog blowers help ram air to reach the ventilating system.

a. True	b. False

3. How can you vary the amount of air entering the ventilation system?

a. Open the flapper valves	c. Both a and b above
b. Pull out vent controls	d. Open the grills

4. The defog system works best when used in conjunction with which of the following components?

a. Ventilation system	c. Air conditioner
b. Bleed air heater	d. Both b and c above

5. Setting the air conditioner control panel to "FAN" will permit cabin air circulation only.

a. True	b. False

6. The tail rotor drive shaft is connected by a belt assembly to the

a. condenser.	c. compressor.
b. evaporator.	d. compressor fan.

7. The freon in the air condition system is a __________ (gas/liquid) when it leaves the evaporator.

8. Cabin air is cooled in the

a. silencer.	c. compressor.
b. condenser.	d. evaporator.

9. The _________ determines how much bleed air is mixed with cabin air in the _________.

10. Operation of the heater will not affect TOT.

a. True	b. False

CHAPTER SEVEN REVIEW ANSWERS

1. b
2. b
3. c
4. d
5. a
6. c
7. gas
8. d
9. Regulator valve…heater silencer
10. b

CHAPTER EIGHT
TH-57B ELECTRICAL SYSTEM

800. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will be able to describe the TH-57B electrical power sources, starter/igniter system, voltage regulation and warning devices, including limitations and requirements.

801. ENABLING OBJECTIVES

Identify the three sources of electrical power for the TH-57B.

1. State the power rating of the battery.

2. State the generator output.

    a. State the purpose of the voltage regulator used in the generator system.

    b. State the purpose of the overvoltage sensing relay.

3. State the purpose of the reverse current relay.

4. Identify the component that allows the generator to function as a starter and state when the igniters receive power.

5. State power requirements for engine start when using external power.

6. Recall the circumstances necessary to illuminate the battery caution lights.

7. State the loadmeter and voltmeter indications that would signify a generator failure.

802. TH-57B ELECTRICAL SYSTEM

The TH-57B electrical system (Figure 8-1) is a 28-volt single-wire system using the airframe as a common negative ground.

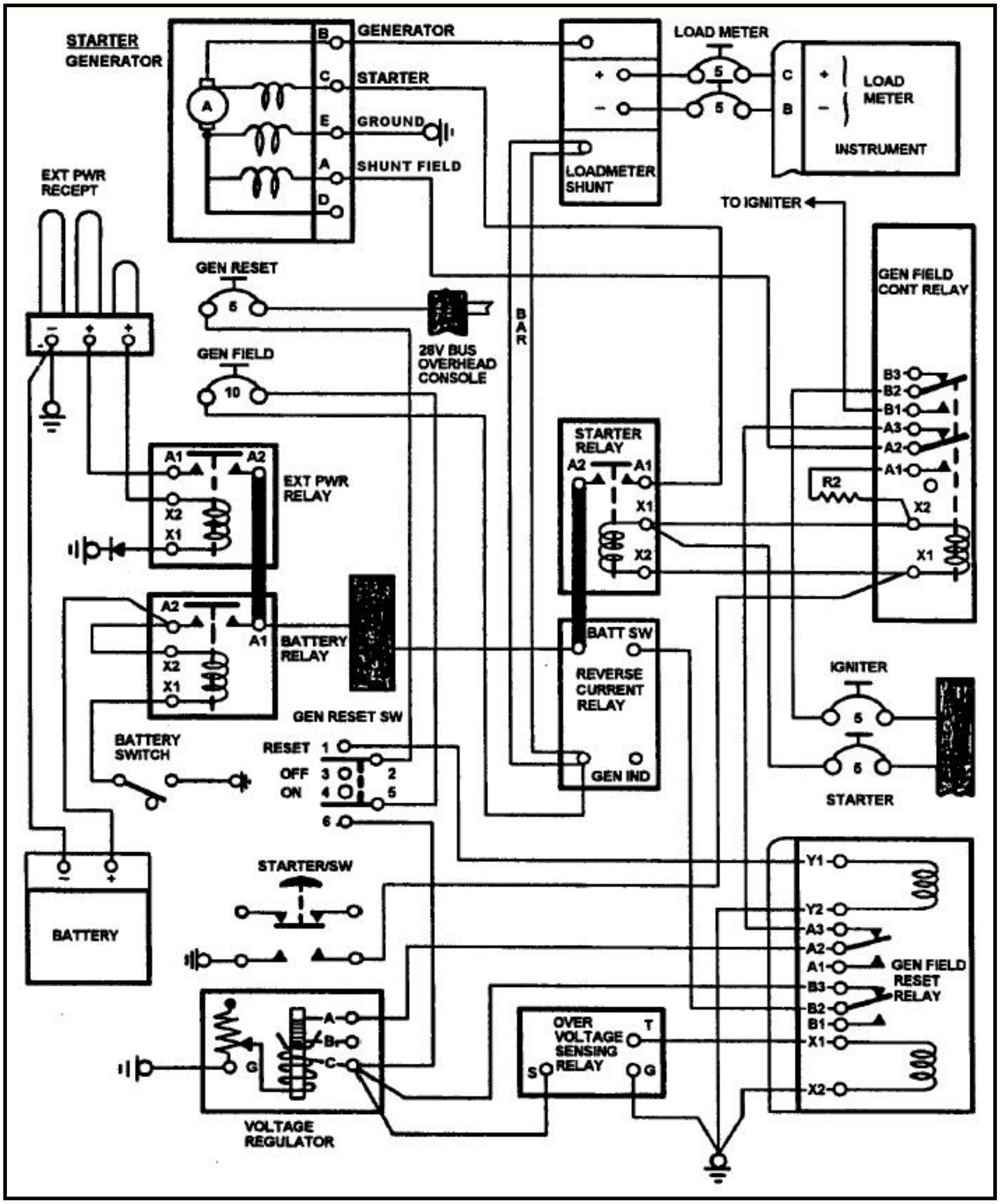

Figure 8-1 Electrical System Schematic

The system is composed of a sealed lead acid battery (SLAB), starter generator, external power receptacle, voltage regulator, and a common BUS. Additionally, circuit breakers, switches, and relays are used to control different components of the electrical system. Circuit breakers and switches are primarily located on the control panel within the overhead console.

Relays are usually located near the component they control. Relays are made up of two circuits: a switch circuit that opens and closes the relay and the main circuit that normally connects a component to a power source.

1. Battery System

The battery system is made up of a battery, battery relay, battery switch, and the required wiring. The battery (Figure 8-2) is located in the nose compartment.

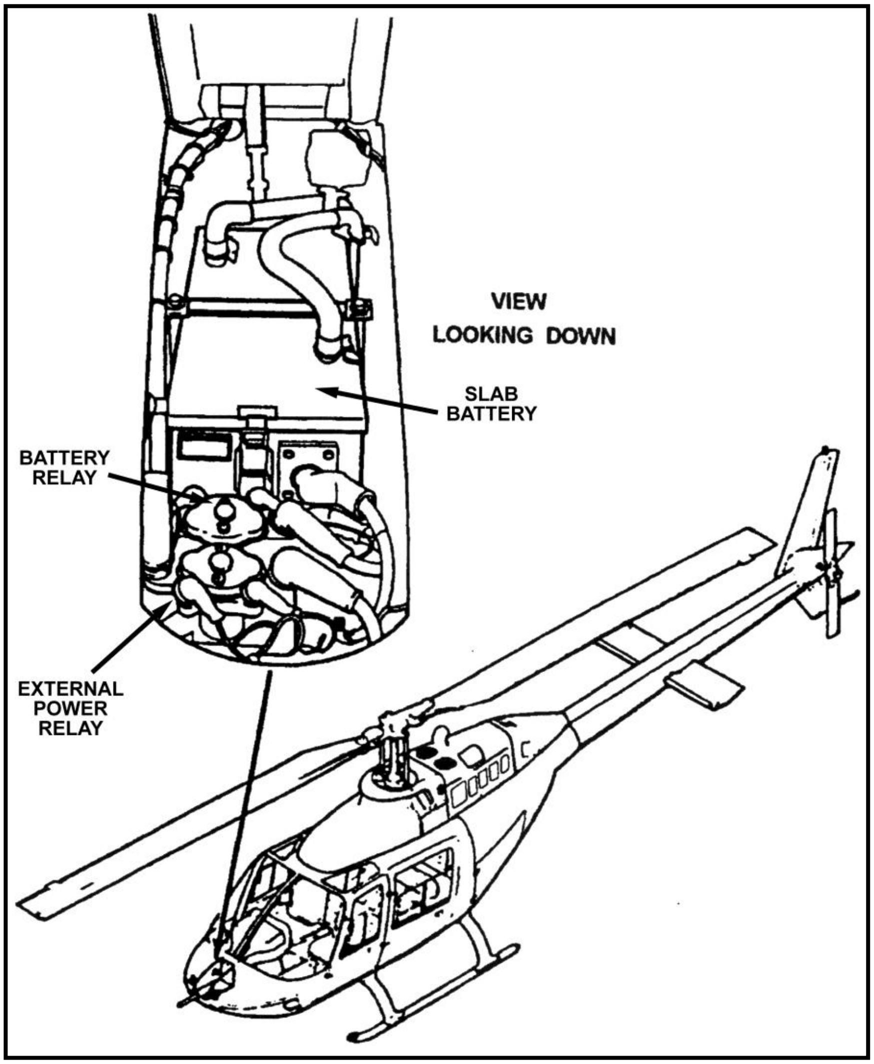

Figure 8-2 Battery Installation

It is a vented Sealed Lead Acid Battery (SLAB). The power rating of the battery is ***24 volts and a discharge rate of 17 ampere-hours.*** Located along with the battery in the nose compartment is the battery relay (Figure 8-2). When this relay is closed, battery power is connected to the common BUS (Figure 8-3). Control of the battery relay, is accomplished by the battery switch (Figure 8-3) located on the overhead console.

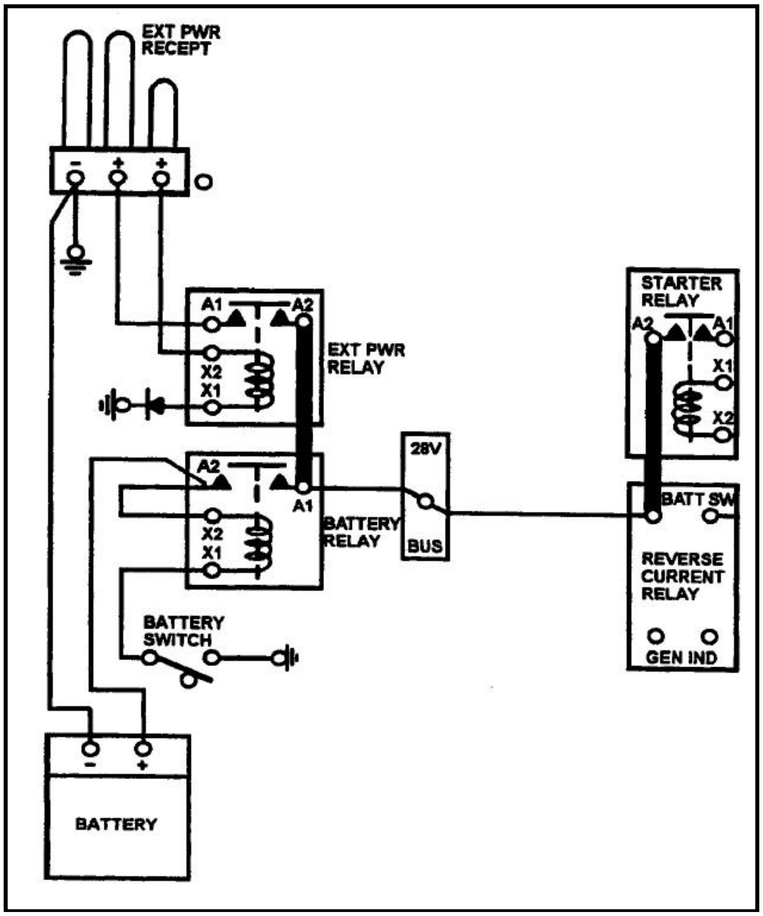

Figure 8-3 Battery and External Power Circuit

Placing the battery switch in the battery position will complete the switch circuit of the relay to ground. This closes the switch circuit of the relay and the circuit is completed from the battery to the common BUS. The common BUS is the distribution point for electrical equipment and is located behind the circuit breaker panel on the overhead console. Circuit breakers connect individual components to the common BUS. Circuit breakers provide circuit protection for the individual components. Circuits can be opened or closed by these PUSH/PULL circuit breakers or balled circuit breaker switches. In the event of an overload or short circuit, in a protected circuit the circuit breaker will pop out showing its white casing. If the problem has been rectified, the circuit breaker can be reset by pushing it back in to the closed position or turning the circuit breaker switch back on.

Two battery caution lights provide an indication of an overheating battery. Temperature is monitored by two temperature-sensitive switches; located in the overtemperature module. When the temperature reaches ***54°C ± 3º***, a switch closes and the ***BAT TEMP*** caution light will illuminate. In the event the battery case temperature reaches ***60°C ± 3 degrees***, a second switch closes. The second switch will complete the circuit and illuminate the ***BAT HOT*** caution light. Both caution light switches will open and turn off the caution lights as the temperature falls below their respective activating temperatures.

2. Starter/Generator System

The starter-generator is a dual purpose unit which functions as an electrical motor (starter) to drive the gas producer section of the engine until reaching self-sustaining RPM. It also functions as a generator, driven by the gas producer section of the engine, to supply 28 volts to a common BUS and a charging current to the battery. The starter-generator (Figure 8-4) is mounted on the aft right side of the accessory gearbox. Components of the starter-generator circuits are located in the aft electrical compartment (Figure 8-5).

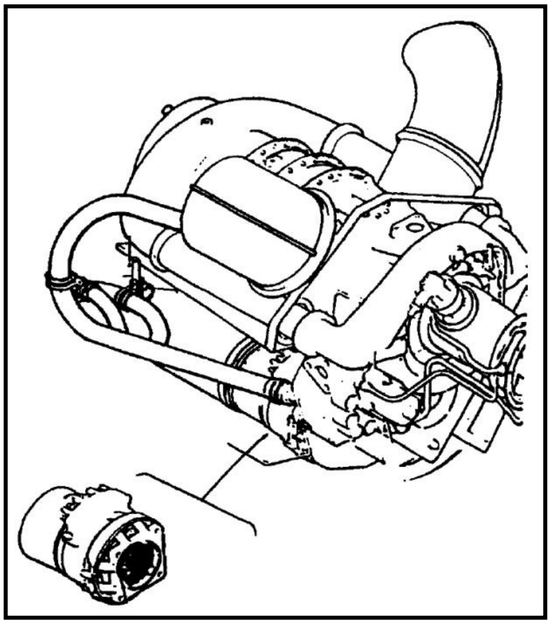

Figure 8-4 Generator Installation

Generator Circuit

The power rating of the generator is 30 volts, 150 amperes. The voltage output is regulated to 28 volts, 105 amperes. Components of the generator circuit (Figure 8-1) and their functions are:

a. A generator switch with three positions: on, off, and reset. The reset position supplies an excitation current to the generator shunt field (activating the generator portion of the starter-generator) and resets the generator reset relay.
b. Voltage regulator – maintains constant generator voltage under varying loads.

c. Reverse current relay

i. Connects generator to common BUS only when proper voltage is obtained.

ii. Prevents current flow from the battery to the generator.

iii. Disconnects the generator from the common BUS when voltage drops below a safe level.

d. Overvoltage sensing relay – trips the generator reset relay, disconnecting the generator from the circuit, when line voltage reaches 31 volts ± 1 volt.

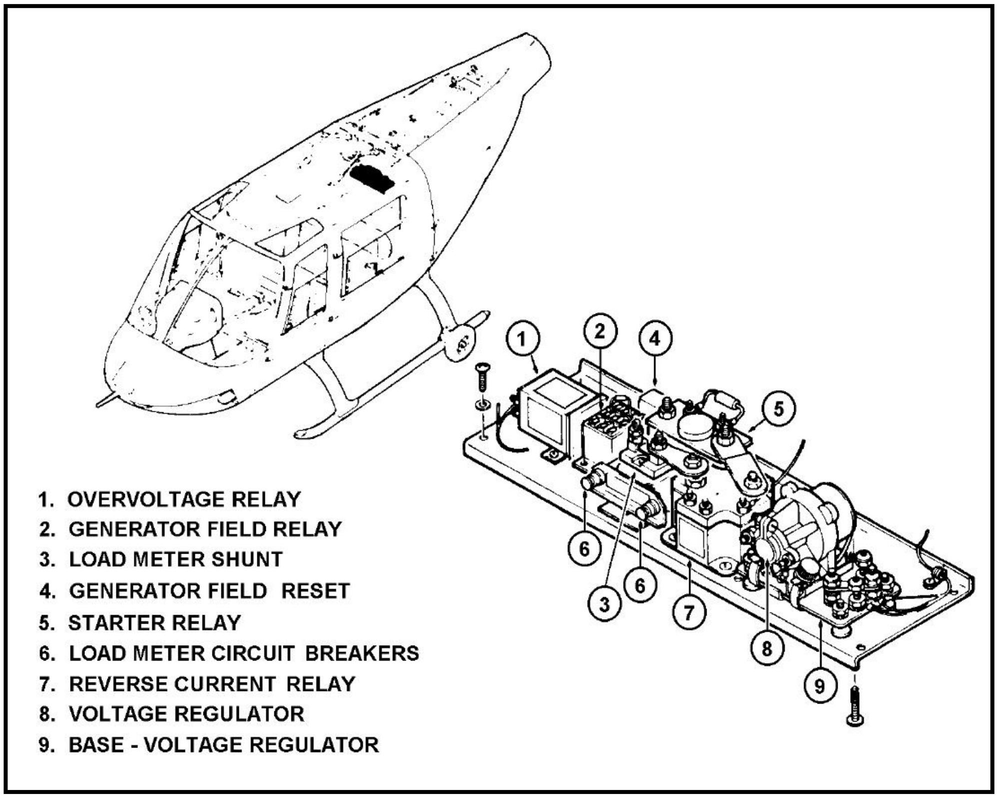

Figure 8-5 Electrical Equipment Shelf

Loadmeter/Voltmeter

The loadmeter monitors the generator and the voltmeter monitors the common BUS. The three caution lights monitor the battery and generator. ***The loadmeter only works with the generator*.** The loadmeter is connected to the loadmeter shunt and reads the electrical load placed on the generator. The loadmeter reads generator load in percentage of load capability. The loadmeter is protected by two circuit breakers located in the aft electrical compartment. The DC voltmeter is connected to the common BUS.

The voltmeter will give direct voltage readings off of the common BUS regardless of the power source. The loadmeter and voltmeter will give an indication of a generator failure. ***The loadmeter will read zero and the voltmeter should read 22 to 24 volts battery voltage when the generator is off-line.***

Starter System

The starter system consists of the starter switch, starter relay, generator field relay, starter motor, and igniter circuit. The starter switch, located on the pilot's collective stick switch box, is a double-pole single-throw switch. When the switch is moved to the ON position, two circuits are completed. One circuit is to the starter relay (Figure 8-5, item 5) located in the aft electrical compartment. Energizing the starter relay completes the power circuit from the common BUS to the starter motor. The other circuit is to the generator field control relay switch circuit actuating the relay. With the relay actuated, the generator shunt field is opened and the generator works as a starter. Actuating the field control relay also completes the circuit from the common BUS to the igniter. These circuits are connected until the starter switch is turned off.

3. External Power Receptacle

Another source of power may be provided by an auxiliary power unit, via the external power receptacle. The external power receptacle is located on the front center of the nose section. The polarized receptacle has two long prongs and one short prong. The short prong is a positive conductor running from the receptacle to the switch circuit of the external power relay. Connecting a power unit to the receptacle will cause the circuit to be complete through the small prong activating the switch circuit and closing the external power relay. One long prong is a positive conductor and the other a negative conductor. When the circuit is complete, they carry the main power load from the external power unit to the common BUS, (Figure 8-3). Use of an external power unit for starting requires a ***28-volt and 400-ampere capability.***

Located on the port side of the instrument panel support pedestal are three 28-volt auxiliary outlets. The auxiliary outlet is used to power test equipment used by maintenance personnel. Circuit protection is provided by a circuit breaker on the overhead console marked auxiliary receptacle.

Programmed Continuity Sensor

TH-57B and C models are equipped with the Benz systems programmed continuity sensor, which provides a continuity check for the electrical circuits to the clear chip, engine chip detectors, transmission chip detectors, and tail rotor gearbox chip detector. When the battery is

turned on, the caution light test button is depressed for more than two seconds, or electric power is interrupted for more than two seconds; the associated caution lights will illuminate and remain illuminated for five seconds, then go out, providing an automatic check of those electrical circuits.

CHAPTER EIGHT REVIEW QUESTIONS

1. The TH-57B uses a __________ battery, rated at ___ volts and ___ ampere hours.

2. The power rating of the generator is _______ volts and _______ amperes. The generator's regulated output is __ volts and __ amperes.

3. Power for electrical equipment is distributed via the ____________________.

4. When generator line voltage reaches ___ volts, the _____ __________ will trip, removing the generator from the circuit.

5. Which component prevents current flow from the battery to the generator?

6. The generator field relay prevents the generator from being driven as a starter.

   a. True b. False

7. The starter receives power from the common BUS.

   a. True b. False

8. The external power source must be capable of providing ___ volts and _____ amperes.

9. The loadmeter works with the generator, battery, and external power.

   a. True b. False

10. When battery case temperature reaches 60°C $\pm$ 3, the battery __________ light will illuminate.

11. The loadmeter presents a continuous ratio of battery power to generator output.

   a. True b. False

12. State the two circuits that are completed when the starter switch is place ON.

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CHAPTER EIGHT REVIEW ANSWERS

1. SLAB…24…17
2. 30…150…28…105
3. Common BUS
4. 31 ± 1…generator reset relay
5. Reverse current relay
6. False
7. True
8. 28…400
9. False
10. Hot caution
11. False
12. Starter…Igniter

CHAPTER NINE
TH-57C ELECTRICAL SYSTEM

900. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will be able to describe the TH-57C electrical power sources, voltage regulation/protection and warning devices, including limitations and requirements.

901. ENABLING OBJECTIVES

1. Identify five sources of DC electrical power for the TH-57C.

2. State the power rating of the standby battery.

3. State the purpose of the standby battery.

4. State the power rating of the main battery.

5. State the purpose of the Remote Control Circuit Breaker (RCB).

6. State the purpose of the RCB override circuit.

7. State the main generator output.

8. Describe the functions of the voltage regulator used in the main generator system.

9. State the purpose of the standby generator output.

10. State the standby generator output.

11. State the power requirements for engine start utilizing external power.

12. Describe each function of the voltmeter panel selector switch.

13. Describe the alternating current system and identify its power sources.

902. TH-57C ELECTRICAL SYSTEM

The TH-57C electrical system (Figure 9-1) is a single-wire direct current system using the airframe as a common negative ground. It has five DC power sources, three BUSES and a 115-volt alternating current system.

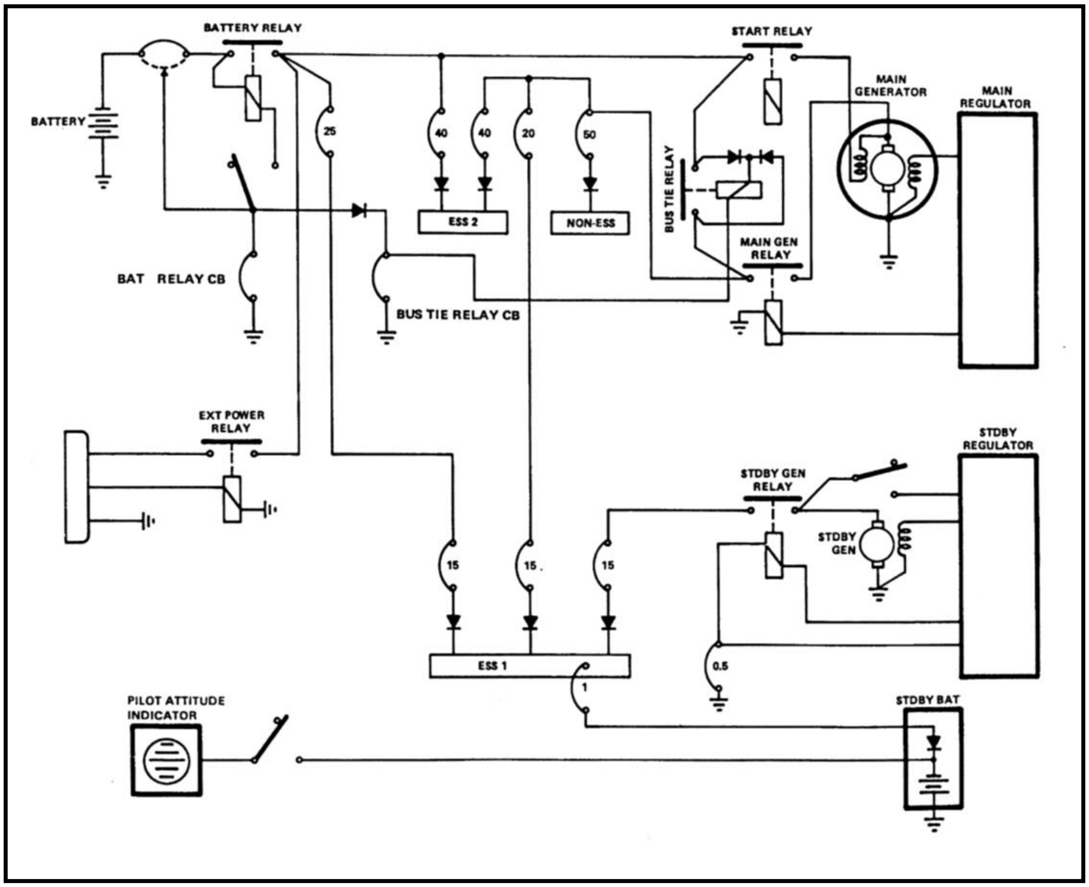

Figure 9-1 DC System

The DC system has five power sources. The power sources consist of two batteries, two generators, and an external power source. Also located in the system are switch panels, circuit breaker panels and various ways to connect components to the BUSES. One new panel (Figure 9-2) is the voltmeter on the center pedestal.

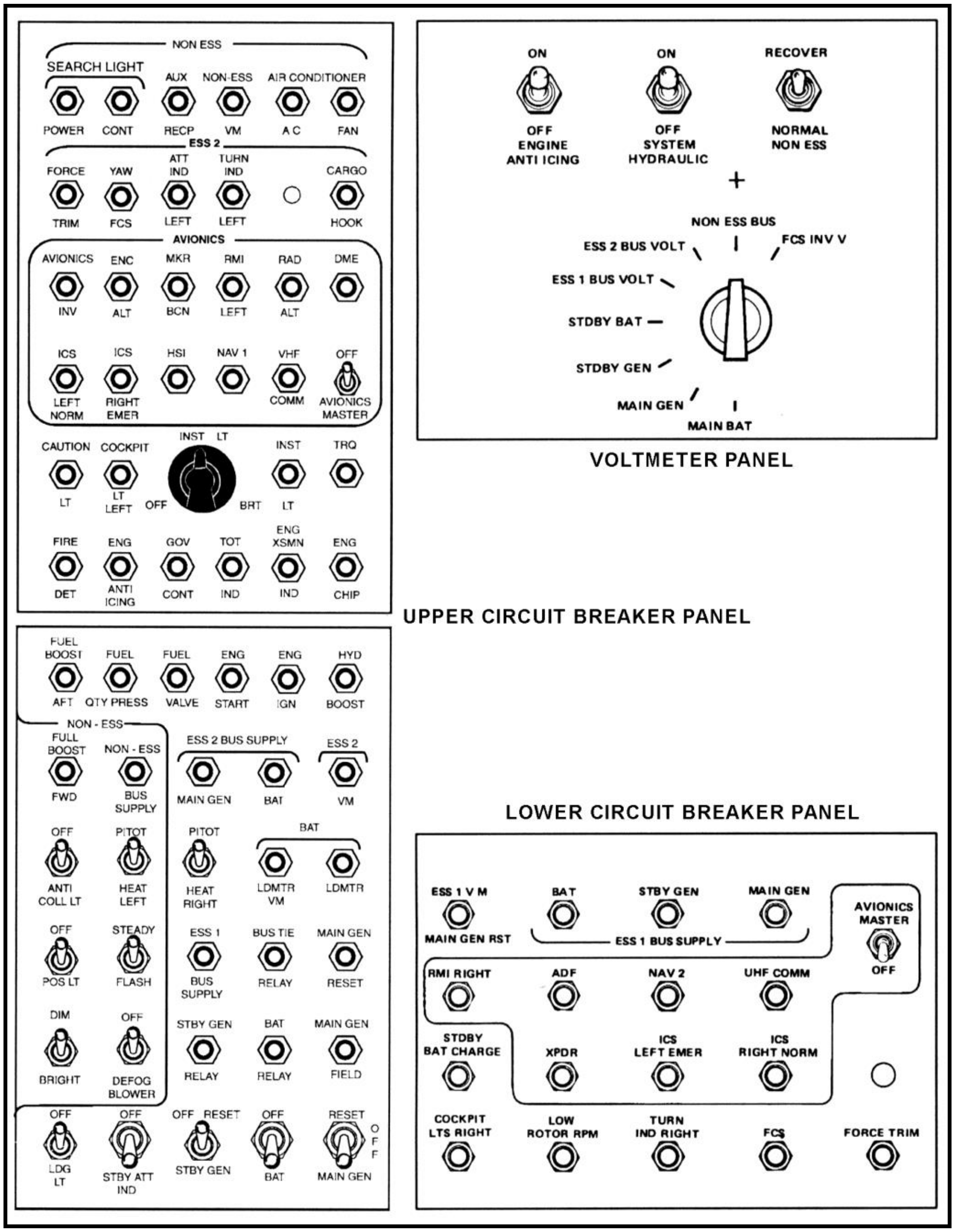

Figure 9-2 Electrical Control Panel

1. Battery System

The battery system consists of a main battery and a standby battery. The standby battery's only function is to supply 22.5-volt power to the pilot's attitude gyro in the event of a complete loss of power to essential BUS #1. The standby battery is a 22.5-volt nickel-cadmium dry cell battery with a charging circuit. The battery (Figure 9-3) is located in the upper right area just aft of the baggage compartment rear bulkhead.

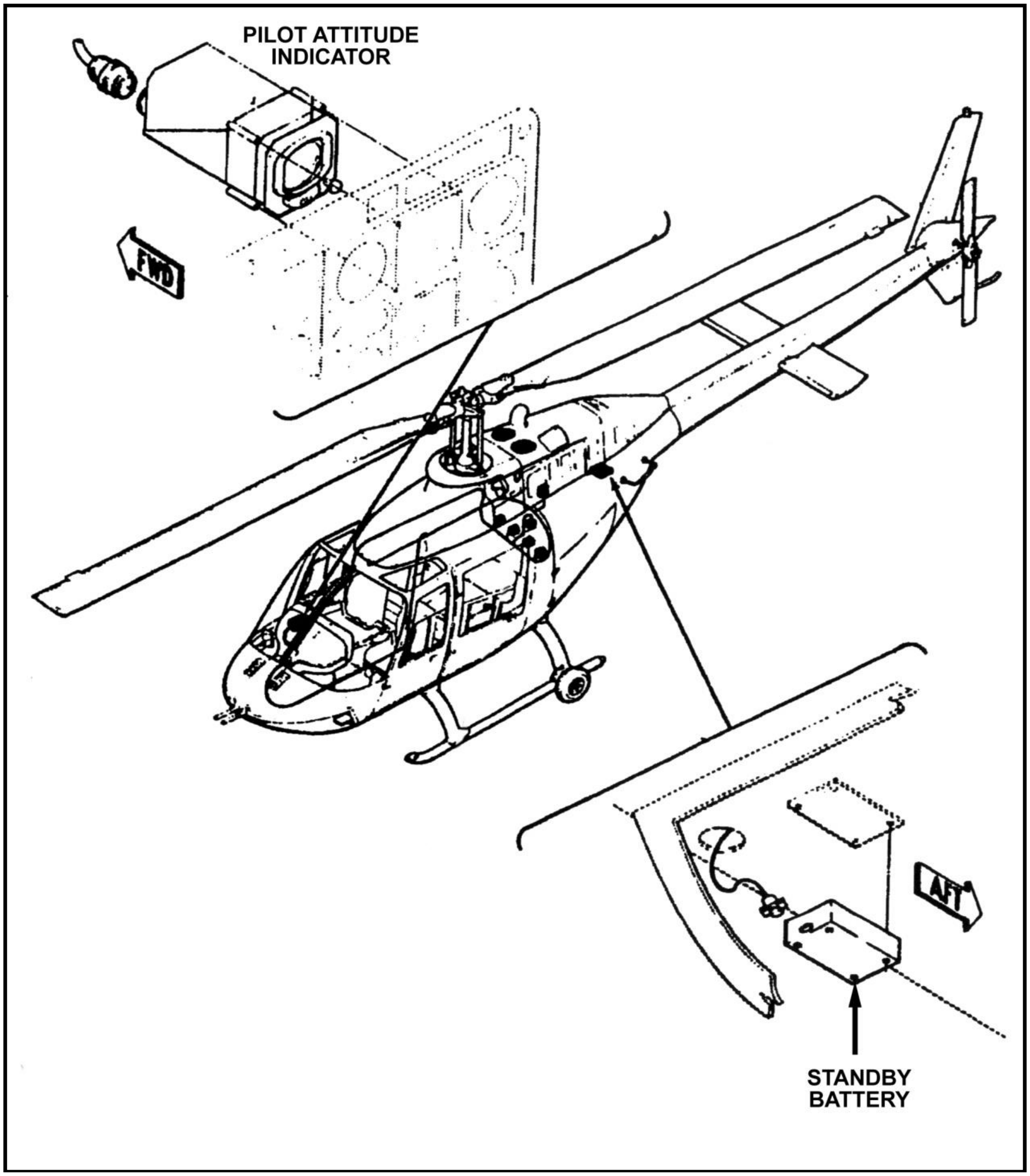

Figure 9-3 Standby Battery

The main battery will power all the aircraft systems if necessary. The main battery system consists of a 24-volt, 17 ampere hour Sealed Lead Acid battery, battery module, and a battery switch. The battery (Figure 9-4) is located in the nose compartment along with the battery module.

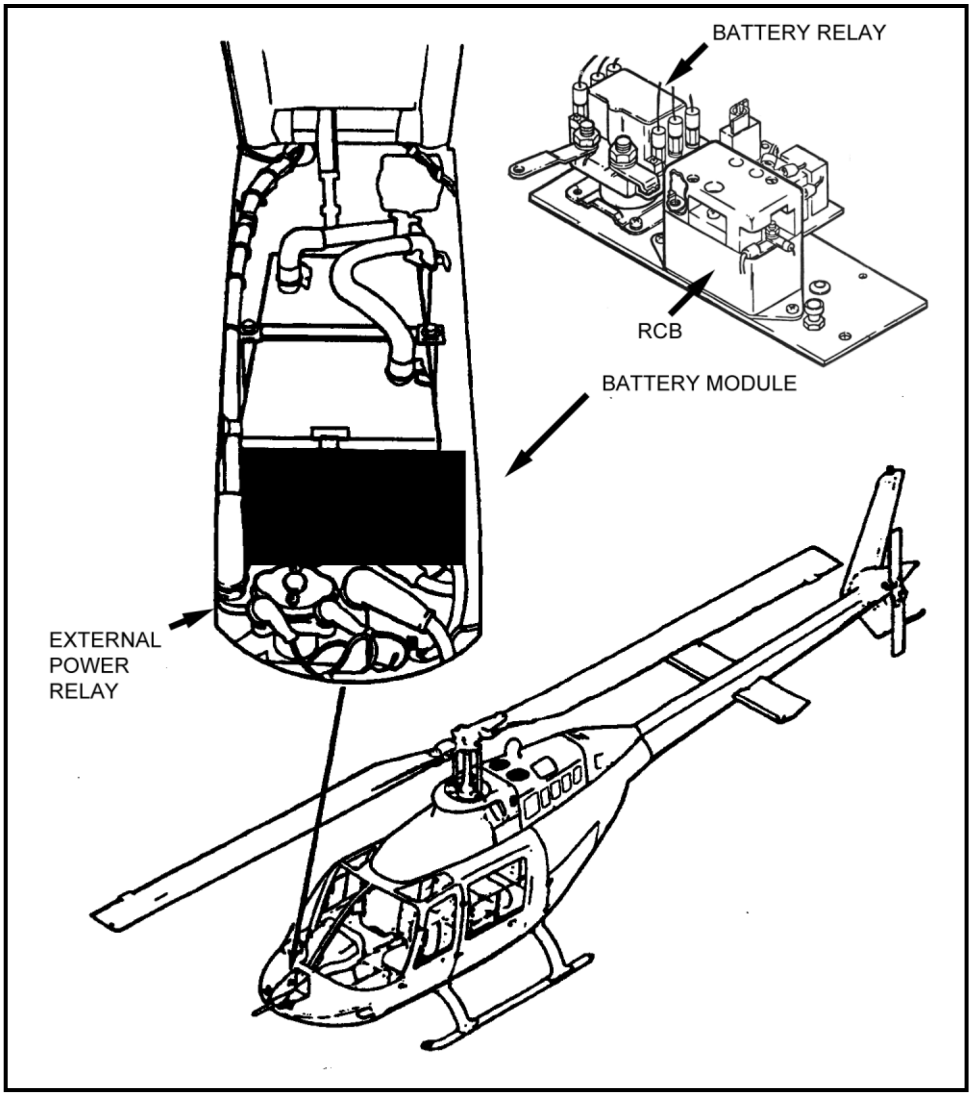

Figure 9-4 Battery Compartment

The battery module consists of the battery relay, RCB and the RCB override circuit. Control of the battery is accomplished by the battery switch located on the overhead console along with the battery relay circuit breaker. Placing the battery switch to the battery position will energize the battery relay and the BUS tie relay and the battery will be connected to the three BUSES. The main battery system has an overload and an overheat sensor to protect the system. The overheat system consists of two temperature sensors and two caution lights.

When battery temperature reaches 54° C ± 3º, a temperature switch will close and the ***BAT TEMP*** caution light will illuminate. If battery temperature reaches 60° C ± 3°, a second switch closes and the ***BAT HOT*** caution light illuminates. The overload sensor, called an RCB is located between the battery and the external power relay. A bimetallic sensing unit in the RCB distorts as current load heats the element. The RCB will sustain a current load of 250 amperes for 10 to 20 seconds at 25° C, but will trip if constant current load exceeds 125 amperes. If the constant current load is excessive, heat will continue to build and the RCB will trip. When the

RCB trips a circuit is completed to ground and the battery relay circuit breaker will open and battery power is removed from the BUSES. After cooling, the RCB will automatically reset, but the battery relay circuit breaker will have to be manually reset. In some cases of high ambient temperatures, low battery voltage, lengthy engine start, or battery recharging, the RCB may trip when no overload exists. Because of the potential to trip during engine starts utilizing the battery, an RCB override circuit (battery protection start override circuit) is provided. The RCB override is incorporated into the battery and starter switch circuit to prevent the RCB from taking power away from the starter before a complete engine start is accomplished. When the starter switch is turned on, the Battery Relay caution light will illuminate, indicating that the RCB circuit is being bypassed.

2. Starter Generator

The starter-generator (Figure 9-5) is located on the underside of the engine, attached to the aft right side of the power accessory gearbox.

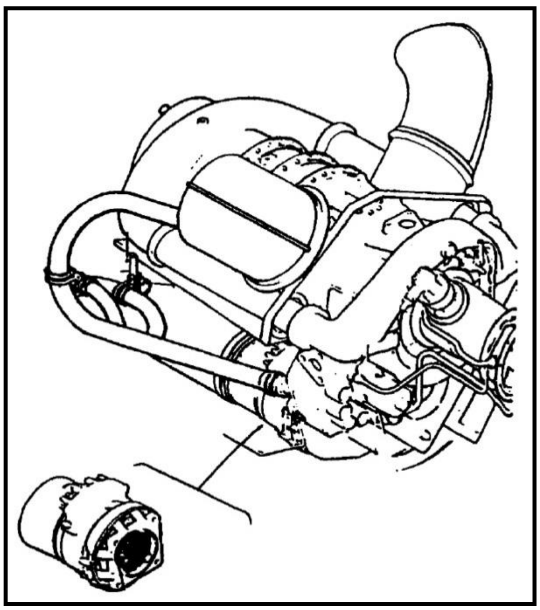

Figure 9-5 Starter/Generator

This unit is used to start the engine, charge the battery, and supply power for operation of all aircraft electrical equipment. The starter system consists of the starter portion of the generator, starter switch, starter relay, and ignition circuit. The starter switch (Figure 9-6) is located on the pilot's collective stick control box.

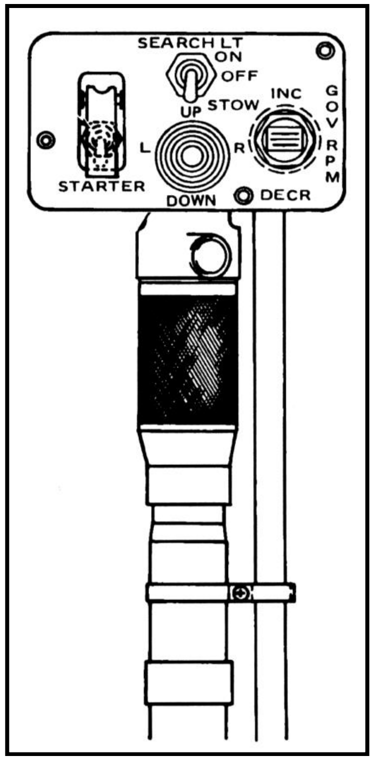

Figure 9-6 Pilot's Collective

The switch is a single-throw, double-pole toggle switch and is covered with a red safety guard. Placing the switch to start completes two electrical circuits. One circuit energizes the starter relay located in the aft electrical compartment which connects the starter motor to the essential BUS #2, while the other circuit energizes the igniter circuit. When self-sustaining engine RPM is reached, the starter is placed off, de-energizing the starter circuits. The generator portion is now ready to supply electrical power to the aircraft.

3. **Main Generator System**

The main generator system consists of a main generator, voltage regulator, generator relay and generator shunt. The main generator is rated at 30 volts, 150 amperes; however, it is regulated to 28 volts, 105 amperes. Ampere loads are measured by a loadmeter connected to the generator shunt. The voltmeter will indicate generator voltage when the voltmeter selector switch is placed in the main generator position. Control of the generator is by the ON/OFF/RESET switch on the overhead console. Prior to placing the switch to the ON position, the switch must first be placed to RESET. (This provides excitation current to the field, enabling the generator to produce current.) When the switch is placed to the ON position, the generator relay energizes and connects the generator to all three BUSES.

4. **Voltage Regulation**

To control the voltage output of the generator, the system has a static type voltage regulator (solid-state) located on the equipment shelf (Figure 9-7). The voltage regulator provides 28-volt regulation, protects the system from over and undervoltage conditions, and prevents reverse current flow. The voltage regulator controls the resistance of the generator field to regulate the voltage output. In the event of an over or undervoltage situation, the voltage regulator will deenergize the generator relay and the generator will be disconnected from the BUSES. The BUS tie relay will open, removing battery power from the nonessential BUS. Battery power can be restored to the nonessential BUS by placing the normal/recover switch to recover. The normal/recover switch is located on the voltmeter panel on the instrument panel.

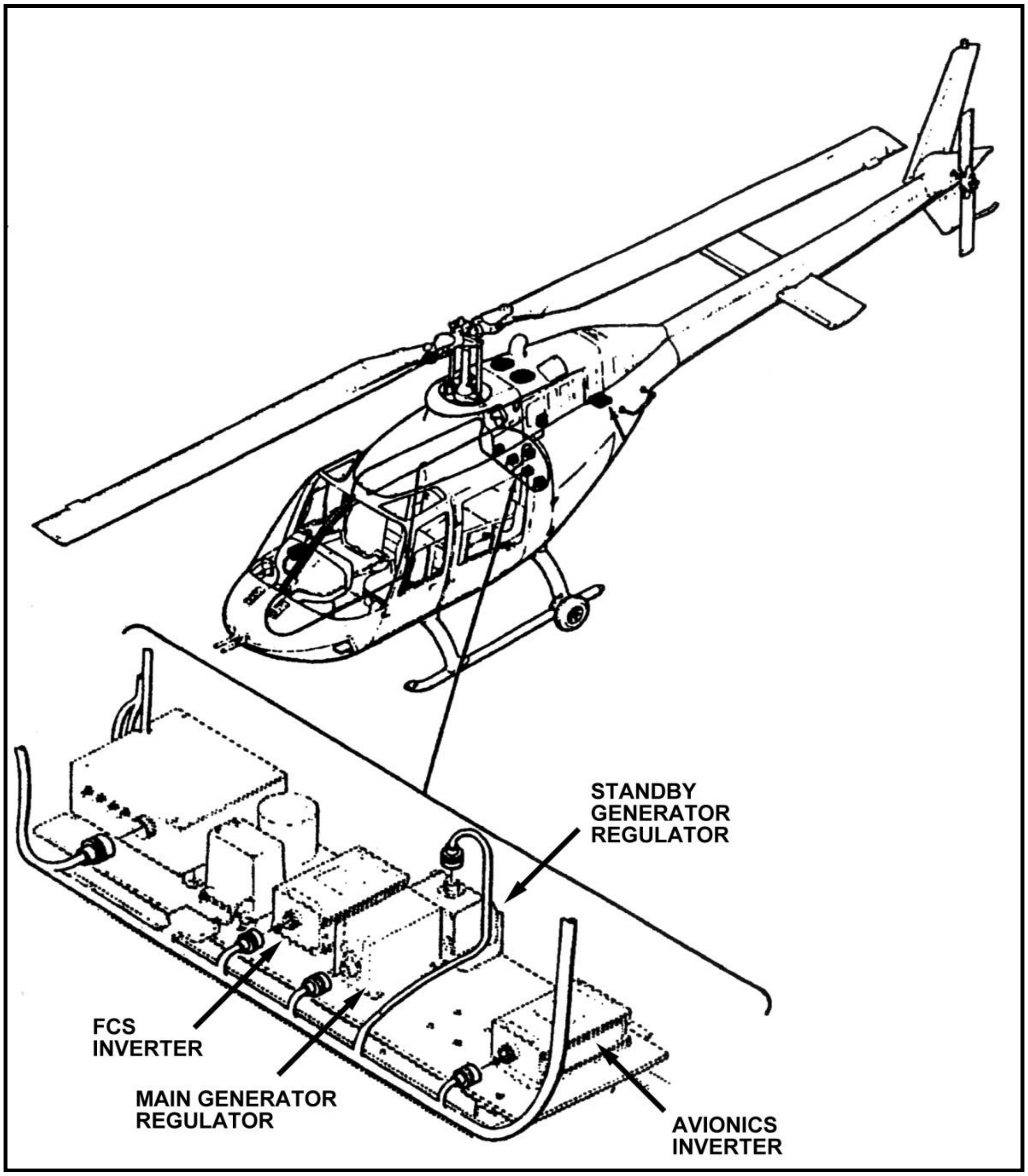

Figure 9-7 Equipment Shelf

5. **Standby Generator**

A standby generator has been added as a backup power source for essential #1 BUS in case the main generator fails. The major components of the standby generator system are the generator, generator relay, voltage regulator, and loadmeter shunt. The standby generator (Figure 9-8) is mounted on an auxiliary pad of the accessory gearbox.

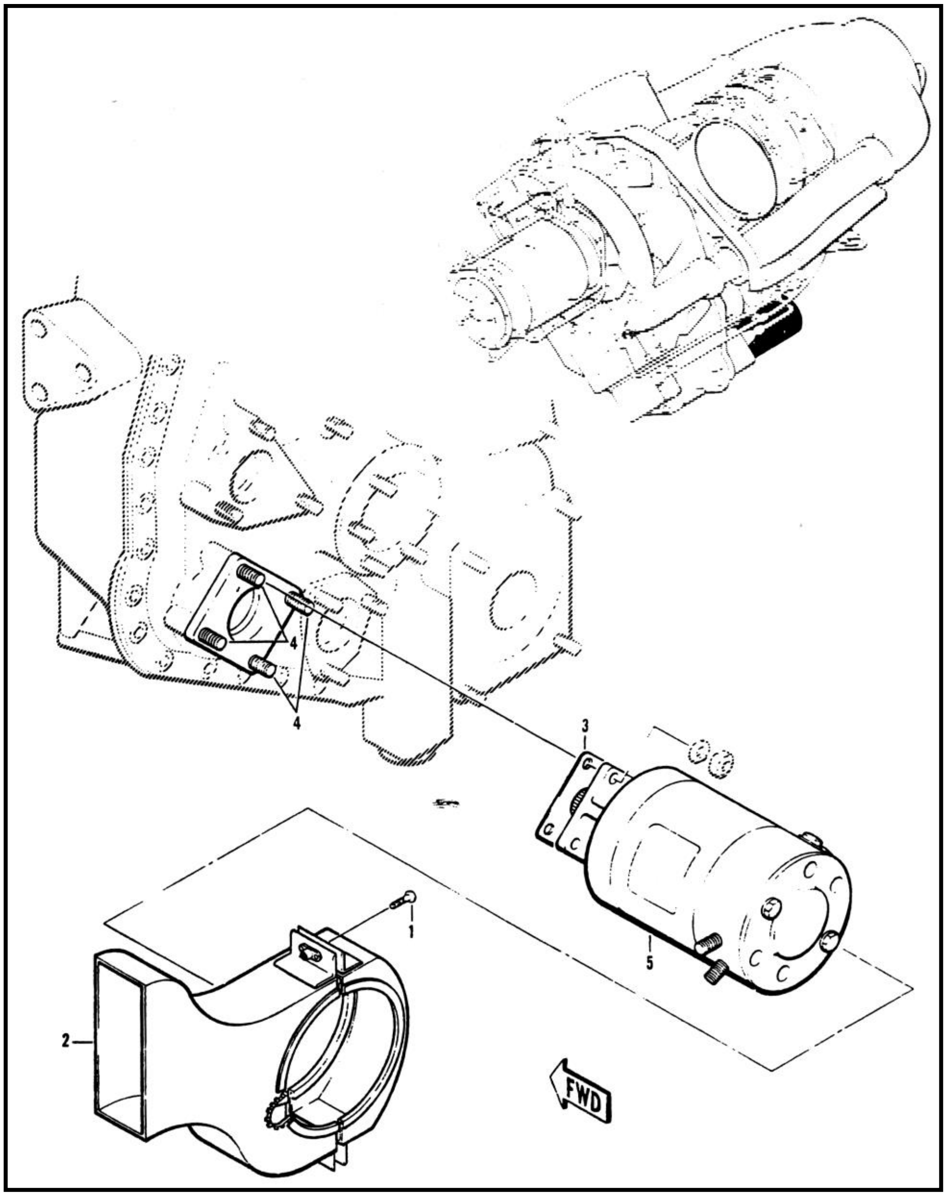

Figure 9-8 Standby Generator

When selected, the standby generator will supply 28 volts and 7.5 amperes to the essential #1 BUS. The standby generator is connected to essential #1 BUS by the standby generator relay. When the standby generator switch is placed to the standby generator position, a circuit is completed from the switch through the voltage regulator to the switch circuit of the relay.

6. **Standby Voltage Regulator**

The standby voltage regulator (Figure 9-7) is a solid-state, linear regulator which obtains its power from the standby generator. The voltage regulator is adjustable and is located on the equipment shelf above the baggage compartment. The standby voltage regulator provides undervoltage, overvoltage, short-circuit protection, and proper system voltage. Since the switch circuit is wired through the voltage regulator, the generator will not be connected until proper voltage is obtained. If an overvoltage is detected, the voltage regulator will deenergize the standby generator relay, disconnecting the generator from the BUS.

7. **External Power**

The external power receptacle is located on the front center of the nose section. Use of an external power unit for starting requires a 28-volt and 400-amp capability. The polarized receptacle has two long prongs and one short prong (Figure 9-4). The short prong is a positive conductor running from the receptacle to the switch circuit of the external power relay. Connecting a power unit to the receptacle will cause the circuit to be completed through the small prong, activating the switch circuit and closing the external power relay. One long prong is a positive conductor and the other is a negative conductor. When the circuit is complete, it carries the main power load from the external power unit to all three BUSES.

8. **Voltmeter/Loadmeter**

There are two gauges to monitor the direct current system voltage and ampere load. The loadmeter and voltmeter are located on the center instrument panel. The DC voltmeter will indicate the voltage for the power source or BUS selected with the voltmeter selector switch on the voltmeter panel (Figure 9-2). The loadmeter will indicate, in percentage, the main or standby generator output, depending on the position selected with the voltmeter selector switch. The loadmeter is connected to each generator’s loadmeter shunt. The shunt provides a proportional current to the loadmeter to give a loadmeter reading. Located on the port side of the instrument panel support pedestal are the three 28-volt DC auxiliary outlets. The auxiliary outlets are used to power test equipment used by maintenance personnel. Circuit protection is provided by a circuit breaker on the overhead console marked auxiliary receptacle.

9. **Inverters**

The TH-57 also has an alternating current system. There are two static inverters (solid-state) located on the forward equipment shelf above the baggage compartment (Figure 9-7). The inverters take an input of 28 volts direct current and produce 400 Hertz, 115-volt and 26-volt alternating current. The avionics inverter works with the avionics and flight control system yaw axis. The Flight Control System (FCS) inverter works only with the flight control system. The inverters are not controlled by switches, but by circuit breakers. The AVIONICS INV is controlled by the avionics inverter circuit breaker on the overhead console. The FCS inverter is controlled through the FCS circuit breaker on the lower circuit breaker panel. The avionics inverter output is the default position of the switch and will be displayed on the AC scale in all other positions of the voltmeter select switch. FCS inverter output will be indicated when the “FCS INV V” position is selected with the voltmeter selector switch.

CHAPTER NINE REVIEW QUESTIONS

1. Name the five sources of DC electrical power for the TH-57C.
2. The power rating of the standby battery is ___ volts DC (VDC) and ___ amp hrs.
3. If total power is lost to the ESS #1 BUS, what unit is powered by the standby battery?
4. If total power rating of the main battery is _______ and ________.
5. What sensors are provided to protect the main battery?
6. How does the RCB function to protect the battery?
7. Main generator output is regulated at ___ VDC and ___ amps.
8. What are the four functions of the voltage regulator utilized with the main generator?
9. In the event of a main generator failure, what BUS(ES) will the standby generator power?
10. What are the power requirements for engine start utilizing external power?
11. The standby generator output is regulated at ___ VDC and ___ amps.
12. How is ac power produced in the TH-57C?

CHAPTER NINE REVIEW ANSWERS

1. Two batteries, two generators, and an external power source.

2. 22.5, 1.8

3. Pilot's attitude indicator

4. 24 VDC, 17 ampere hrs.

5. Overload (current) and overheat sensors

6. The RCB will trip under a constant load of 125 amps and remove the battery from the electrical system.

7. 28, 105

8. 28V regulation, overvoltage protection, undervoltage protection, and prevents reverse current flow.

9. ESS #1

10. 28 VDC, 400 amps.

11. 28, 7.5

12. Two static inverters convert DC power to ac power.

CHAPTER TEN
THE MINISTAB SYSTEM

1000. TERMINAL OBJECTIVE

Upon completion of this chapter, the student will interpret the operation of the MINISTAB Flight Control System and be able to identify its components along with their associated functions and limitations.

1001. ENABLING OBJECTIVES

1. Identify the general characteristics and functions of the MINISTAB system.

    a. Identify the controller buttons and their functions.

    b. Identify the functions of the force trim and STAB buttons found on the cyclic.

    c. Describe the functions of the actuators and trim damper units.

2. Identify the major components of the MINISTAB system and state how they function independently and together in the flight control system.

3. Identify the operational functions and limitations of the MINISTAB system.

    a. State how movement of the flight controls operate with the various computers in the MINISTAB system to control flight.

    b. Identify the airspeed and altitude limitations associated with the MINISTAB system.

1002. THE MINISTAB SYSTEM

The TH-57C model helicopter incorporates a system designed to provide attitude retention and smooth pilot input to the controls. This system is called the MINISTAB Automatic Flight Control System. But don't let the term "automatic" fool you. To gain the greatest benefit from the MINISTAB'S system, you must understand three areas.

1. System description and functions.

2. The major components of the system.

3. System operation.

System Description/Functions. The MINISTAB is a basic three-axis stabilization system with force trim and rate dampening in all three axes. Each axis has a system that includes a trim damper unit, a computer, and an actuator. The air data computer provides airspeed and altitude information to the system and the controller and actuator position indicator provide the pilot with system information. A junction box works with all three axes.

The following is a general description and can be applied to all three axes. Don't worry about details now. Just get the idea of how it works.

Installed in the control tube is an actuator. A gyro in a computer senses changes in attitude and sends a signal to the actuator which makes a control input…by varying the length of the control tube…extending or retracting. This control input is transferred to the main or tail rotor systems providing attitude retention. Now, if the pilot moves the controls, the computer switches to standby to eliminate opposition to pilot input. When control movement stops, the computer takes over again, maintaining the new attitude. Basically, all three axes operate the same. Now, let's look at some components in more detail. First, in the cockpit, located on the top of the pedestal between the pilot and copilot is the ***MINISTAB Controller*** (Figure 10-1). It has four buttons with lights to indicate normal operation. The ***FT*** button engages and disengages the force trim system. Power is supplied by the essential #1 and essential #2 BUSES. The ***STAB*** button engages and disengages the flight stabilization systems. The STAB is powered by essential BUS #1 and essential BUS #2. With both force trim and STAB buttons on, the system is in the automatic mode. The ALT button engages and disengages the altitude hold mode. The ***TEST*** button initiates a test to the MINISTAB system.

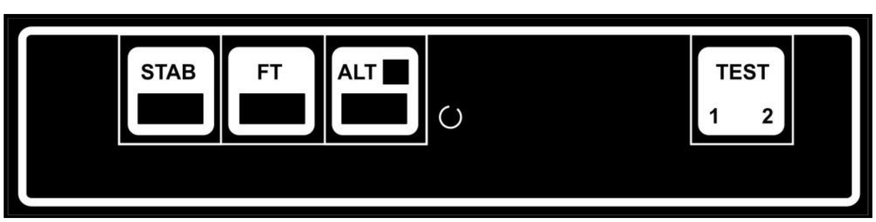

Figure 10-1 Ministab Controller

Two buttons (Figure 10-2) are depicted on the cyclic grip. While the ***force trim*** (maneuver) button is held down, the MINISTAB goes to standby and the force trim gradient spring is disengaged. Release of the button resets both systems. Depressing the ***STAB*** remote button on the cyclic turns the MINISTAB system on or off. Now, let's look closely at an actuator.

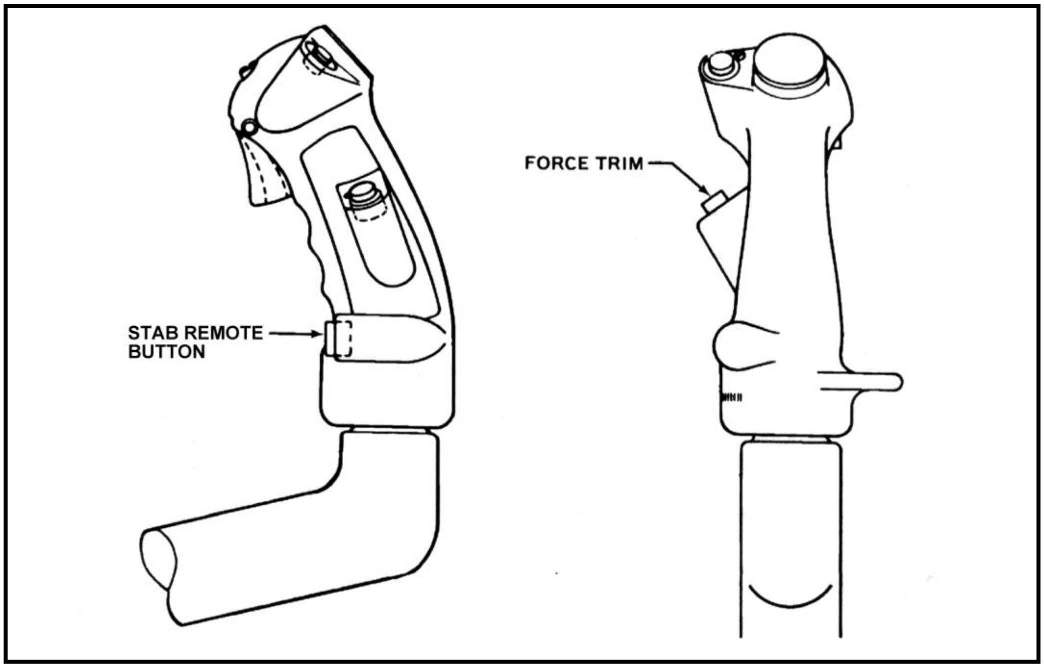

Figure 10-2 Force Trim and Stab Control Buttons

The Electromechanical Actuator (Figure 10-3) is basically a high-speed motorized jackscrew using a DC permanent magnet motor to drive it. A feedback transducer determines the position of the actuator and sends a signal to the actuator position indicator in the cockpit. The actuator has a low output force and is assisted by the aircraft's hydraulic boost system for cyclic inputs. The yaw system does not have hydraulic assist so a larger actuator is installed. The yaw also has a temperature switch to cycle the yaw on and off when the motor overheats.

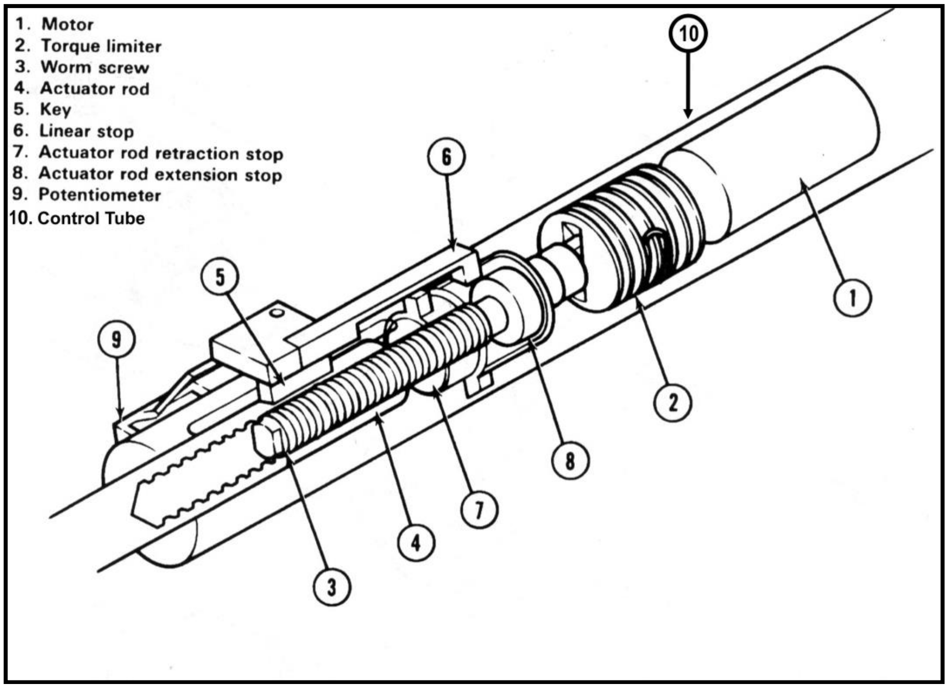

Figure 10-3 Electromechanical Actuator

The cyclic actuators are installed in the top of the cyclic control tubes. The output shaft is connected directly to the hydraulic booster pilot valve input. This location serves to isolate actuator motion from the pilot controls. The rudder actuator is installed in line with the tail rotor control tube. Signals from computers cause the actuator to move about a neutral point with a total movement of about one inch. Both cyclic actuators move simultaneously. They move in opposite directions for roll input and in the same direction for pitch input. With the system off, no complete signal is supplied to the actuators and they will move to center. The flight control tubes then operate as a standard control tube. Now, let's look at a ***Trim Damper Unit*** (TDU). As the name suggests, these units are multipurpose with force trim and damper sections. The force trim operates as a standard force gradient, providing artificial feel while maintaining the last control position. The damper serves to smooth pilot input into the automatic flight control system. It has the additional benefit of smoothing pilot input at all times.

Power for the force trim is controlled by the FT button on the MINISTAB controller. The force trim maneuver button is used to momentarily disengage the pitch and roll force trim system. The pedal micro switches are used to momentarily disengage the yaw force trim system. Circuit protection is provided by the upper and lower circuit breaker panels. Circuit breakers on the overhead panel are labeled Force Trim and Yaw FCS. Circuit breakers on the lower panel are labeled Force Trim and FCS.

Major Components. The major components of the system are as follows:

1. Junction box

2. Pitch computer

3. Roll computer

4. Yaw computer

5. Air data computer

The junction box interconnects components of the system. The roll computer and junction box are under the pilot's seat, and the pitch and yaw computers are under the copilot's seat. All three axis computers are identical. Each axis computer contains a rate gyro, memory circuit (integrated rate), and Integration Cutoff (ICO) circuit. Within each computer, the rate gyro senses movement about its axis, allowing the computer to detect any deviation from the "attitude" stored in the memory circuit. The computer then sends a correction signal to the actuator, which makes the appropriate control input. This is how aircraft attitude retention is provided. ICO places the attitude hold function in standby and cancels memory, but the computers will continue to provide aircraft stabilization. ICO occurs when:

1. The pilot moves the cyclic or pedals in the axis of flight control movement only (above 40 kts a roll input will also ICO the yaw axis).

2. The pilot depresses the cyclic force trim button, in the roll and pitch axis (above 40 kts, this will also cause yaw axis ICO).

3. The force trim system is off.

Attitude retention (integration) is restored when **all** of the following conditions are met:

1. The pilot ceases to apply control inputs.

2. The cyclic force trim button is released.

3. Movement about the axis falls below 1.5º per second.

4. The force trim system is on.

The air data computer contains transducers that sense airspeed and attitude changes and it also incorporates an airspeed trip switch. The airspeed trip switch tells the FCS when the helicopter is above 40 kts indicated airspeed. This switch works in conjunction with altitude hold and the yaw axis computer (turn coordination function). Now let's look at how the components of the system work together.

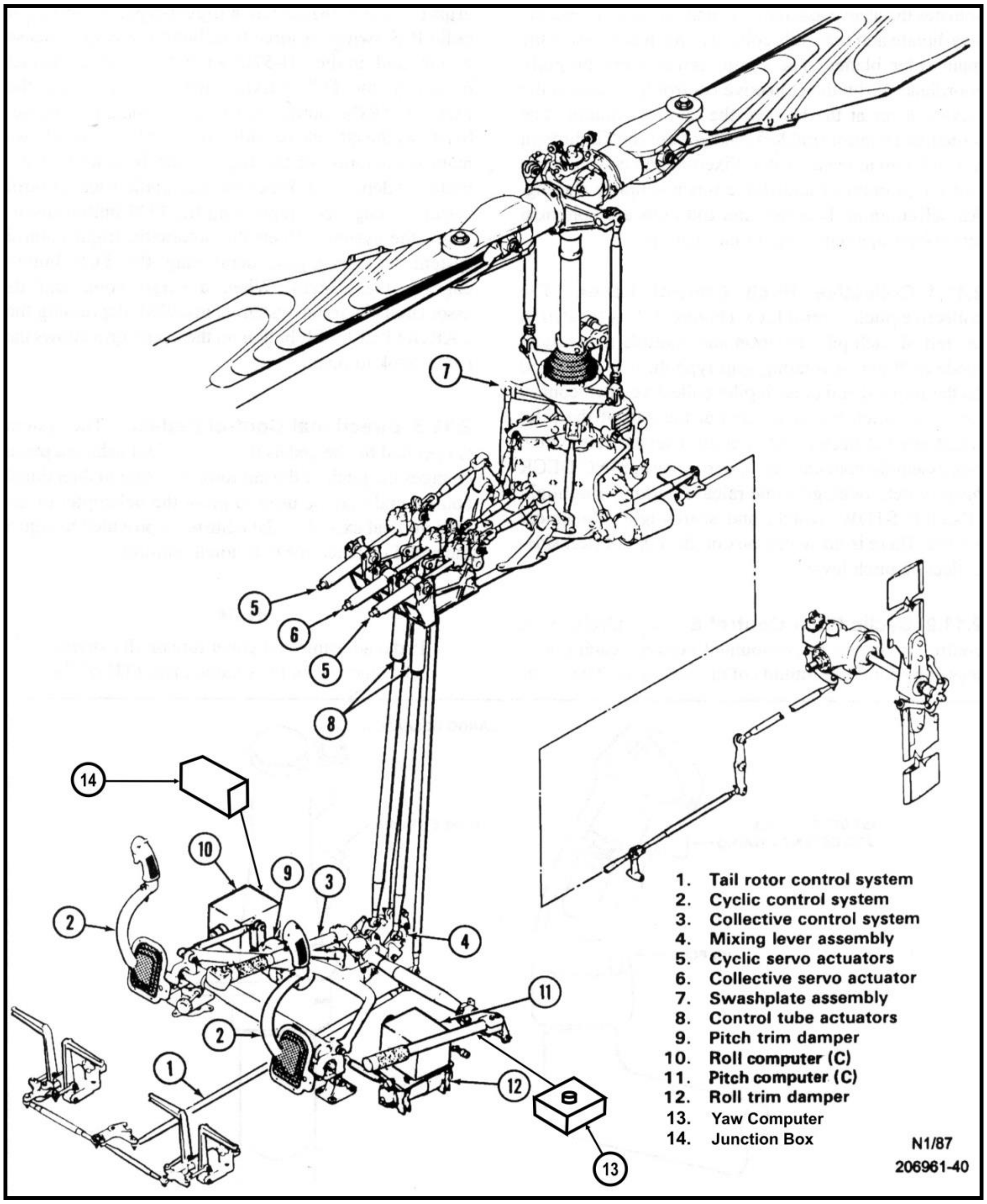

Figure 10-4 Ministab and Flight Control System Components

System Operation. Now that you know what each component is, let's trace the operation of the system. We'll begin with examples in each of the three axes and end with the altitude hold function. For each example that follows assume all systems are operational and the force trim and STAB systems are ON.

You have already seen how the computer maintains an attitude. The Pitch computer senses changes and makes corrections to maintain the aircraft fuselage in that particular pitch attitude by sending equal signals to both cyclic actuators. Now, ***to change to a new pitch attitude***, all you have to do is move the cyclic fore or aft. A microswitch in the pitch TDU senses this longitudinal cyclic movement and activates the pitch computer ICO. Once you stop moving the controls, ***the computer waits for movement about its axis to stabilize below 1.5º per second***…and ***900 milliseconds later*** the ICO is secured again. This delay lets the aircraft settle down, then the computer maintains the new attitude. The roll axis system functions in the same way, except the computer only senses change in the roll axis. Remember for roll inputs, the cyclic actuators move simultaneously in opposite directions. To accomplish this, equal signals are sent to both cyclic actuators, except one signal is reversed in polarity for roll input, left or right. Again, lateral cyclic movement causes ICO to occur and once the aircraft stabilizes, the roll computer maintains the new roll attitude. For the yaw axis, the principle is the same. A rate gyro in the yaw computer senses changes about its axis and makes inputs to the tail rotor controls to hold the last heading set. The yaw system has the microswitches located in the pedal assemblies and not in a TDU. When the pedals are moved, the microswitch will ICO the computer. Once the computer detects the aircraft has settled down, it will maintain the new heading. The microswitch will ICO the computer and once the computer detects the aircraft has settled down, it will maintain the new heading.

Up to now, we have been moving the controls without depressing the force trim and only the axis the controls are moved in is affected. So, what happens when we first depress the force trim (maneuver) button and then move the controls? Anytime the cyclic force trim is disengaged, the pitch and roll computers go to ICO (If above 40 kts the yaw computer will ICO with the roll.) Once the button is released and aircraft motion settles down, the computers take over full control again, maintaining the new attitude.

Now let's look at how altitude hold works. ***Depressing the altitude hold button*** on the controller ***will engage the air data computer*** and maintain the selected altitude. ***The air data computer contains an airspeed trip switch. The airspeed trip switch prevents the altitude hold function from working if airspeed is less than 40 kts***. With airspeed above 40 kts, and altitude hold engaged, the altitude hold circuits of the air data computer will determine if the aircraft is above or below the desired altitude. Then an altitude error pitch signal that is proportional to the amount of error is sent to momentarily cause the pitch computer to go to ICO. Notice, altitude hold only affects the PITCH AXIS. Roll and yaw are not affected. ***So, it can be said the computer uses attitude to maintain altitude.***

If you are low, pitch angle will change to raise the nose and as a result, airspeed will decrease. If you are high, airspeed will increase as the nose is lowered to descend. ***The air data computer will maintain altitude except that if the computer senses an altitude error signal greater than 150 feet, the air data computer will automatically disengage.*** The altitude hold green light goes out and the amber light illuminates. To reestablish the system the altitude hold switch must be re-engaged. One additional function of the air data computer is to cause a yaw ICO during cyclic roll inputs, to allow coordinated turns above 40 kts. This prevents the yaw computer from inhibiting heading change during a turn. Also, above 40 kts the air data computer will cause the yaw to ICO when the cyclic force trim maneuver button is depressed. The FCS is monitored by a caution light on the master caution panel. The light labeled FCS will illuminate for approximately five seconds when altitude is momentarily turned off or disengaged. The light will stay illuminated when there is a fault in the system.

Knowledge and use of the MINISTAB FCS will reduce your workload as a pilot and improve your flight control. You can now fly more relaxed and devote your extra energy to flight safety, instrument scan, and other equally important flight tasks.

CAUTION

With the MINISTAB system in operation, your aircraft limitations are reduced. You must consider the effect of these limitations during your flight planning. For example, ***with the MINISTAB in operation, your TH-57's velocity that should never be exceeded (V_{NE}) is reduced to 122 kts at density altitudes of 3000 and below.*** The V_{NE} for aircraft flying above 3000 feet density altitude will depend on gross weight and density altitude flown. Check your NATOPS for other restrictions.

CHAPTER TEN REVIEW QUESTIONS

1. The MINISTAB system assists the pilot in maintaining flight attitude.

   a. True b. False

2. The buttons associated with the controller are __________, __________, __________, and __________.

3. The actuators associated with the _____ and _____ systems have hydraulic assist.

4. What momentarily disengages the pitch and roll force trim system?

   a. Remote STAB button c. Trim damper unit
   b. Force trim maneuver button d. Altitude hold button

5. In addition to moving the flight controls and disengaging the force trim, placing ___ ON will cause computer ICO.

6. Once you stop moving the controls and movement has stabilized below 1.5° per second, ____________ later ICO is secured.

   a. 60 seconds c. 90 nanoseconds
   b. 9 milliseconds d. 900 milliseconds

7. Altitude hold works through the ____________.

   a. pitch trim damper unit c. air data computer
   b. yaw computer d. roll computer

8. The airspeed must be greater than 40 kts for the __________ function of the MINISTAB system to work.

   a. airspeed hold c. force trim
   b. altitude hold d. damper trim

9. Altitude errors greater than _______ feet will cause the air data computer to disengage.

   a. 150 c. 250
   b. 200 d. 300

CHAPTER TEN REVIEW ANSWERS

1. A
2. STAB…FT…ALT…TEST
3. Pitch…roll
4. b.
5. Altitude hold
6. d.
7. c.
8. b.
9. a.

APPENDIX A
GLOSSARY

A100. NOT APPLICABLE

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APPENDIX B
TRAINING SYNOPSIS

B100. ADVANCED PHASE SYNOPSIS

DISCIPLINE: Engineering/Systems

COURSE TITLE: TH-57B/C Systems

PREREQUISITES: None

B101. Terminal Objective

Upon completion of the course TH-57B/C Systems, the student will possess an understanding of the basic design features of the TH-57B/C, including all systems and power plant capabilities, demonstrating a functional knowledge of the material through successful completion of an end-of-course examination with a scoring a minimum score of 80% correct.

Audio Visual:

Chapter 1	Introduction to the TH-57	4B88/6	(13:00)
Chapter 2	The Allison 250C-20J Engine-Part 1	4B88/7-1	(18:00)
	The Allison 250C-20J Engine-Part 2	4B88/7-2	(13:30)
	The 250C-20J Engine Controls	4B88/7-3	
Chapter 3	Fuel System	4B88/12-2	(15:00)
Chapter 4	TH-57 Power Train-Part 1	4B88/9-1	(16:55)
	TH-57 Power Train-Part 2	4B88/9-2	(24:00)
Chapter 5	TH-57 Main and Tail Rotor Systems	4B88/8	(15:00)
	TH-57 Flight Control System	4B88/10	(15:00)
Chapter 6	TH-57 Hydraulic System	4B88/11-1	(15:00)
Chapter 7	TH-57 Environmental Control Sys.	4B88/11-2	(17:30)
Chapter 8	TH-57B Electrical System	4B88/15	
Chapter 9	TH-57C Electrical System	4B88/12-1	(21:20)
Chapter 10	TH-57 MINISTAB System	4B88/16	(22:45)

Additional Audio Visual

TH-57 Rotor Brake, Cargo Hook and Landing Light	4B88/17	(16:25)