HYDRAULIC BRAKE SYSTEM - DESCRIPTION AND OPERATION

1. Description

A. The hydraulic brake system includes four power brake valves located directly below the rudder pedals, six shuttle valves (two under the floorboards and two in each main gear wheel well), two parking brake valves located under the right floorboards between frames 10 and 11, multiple disc brake assemblies, and four hydraulic fuses (one in each brake line).

B. The hydraulic brake system incorporates an anti-skid braking system which ensures the proper amount of brake pressure to each brake. The anti-skid system is explained in 32-44-00.

C. The parking brake system consists of one Parking Brake Handle (mounted on the LH side of the pedestal) that operates two parking brake valves installed in the main hydraulic brake lines.

D. Component Description

(1) Each multiple disc brake assembly consists of two rotating discs which are driven by radial tangs engaging keyway slots in the wheel. They rotate on either side of a stationary disc keyed to the torque tube. The stationary disc, pressure plate, and back plate provide rubbing surfaces for the rotating disc. The back plate, pressure plate, and torque tube are bolted to the brake housing. The housing contains five brake pistons, four return springs and automatic adjustment units, and an inlet and bleeder port. The piston cavities are interconnected by drilled passages to provide simultaneous piston actuation with equalized pressure on each piston. There is one brake assembly for each main landing gear wheel.

(2) Power brake valves are installed forward of each rudder pedal and control hydraulic pressure to the brake assemblies. There are three ports on each valve assembly: system pressure, return, and brake pressure. The valves are manually operated by linkages connected to the rudder pedals.

(3) Hydraulic fuses are located in each wheel well adjacent to the anti-skid valves and prevent the loss of system pressure and fluid due to brake line failure. The fuses close when 5.5 (±1.1) fluid ounces of hydraulic fluid pass through the fuse.

(4) The two parking brake valves are interconnected and are manually operated. The parking brake valves are installed in the brake lines and are normally open. When pressure is applied to the brake assemblies and the parking brake valves are actuated, the valves will block off the brake lines, retaining brake pressure on the brake assemblies.

2. Operation (See Figure 1.)

A. Depressing the brake pedals opens the power brake valves and directs hydraulic pressure from the nose gear down line through the anti-skid control valves, brake fuses, and shuttle valves to the brake assemblies. Built into the gear retraction system is an integral braking system to stop wheel rotation before full retraction. During retraction, the return landing gear hydraulic fluid passes through a restrictor in a return line which is common to the brakes. A restrictor in the line creates 100 to 180 psi back pressure in the brake system to lightly apply the brakes and stop wheel rotation. When the landing gear reaches the up-and-locked position, the pressure is removed from the brake system, and the brakes are released. In case of hydraulic system failure, pressure for brake application is provided by emergency air pressure. (Refer to 32-45-00.)

B. The parking brake is applied by depressing the brake pedals and moving the Parking Brake Handle to lock the hydraulic pressure in the brake lines.

EMERGENCY AIR BRAKE SYSTEM - DESCRIPTION AND OPERATION

1. Description

A. The emergency air brake system consists of one (1) emergency brake control valve which is connected to a high-pressure emergency air bottle and to the hydraulic brake system at each of the four (4) shuttle valves.

B. Component Description

(1) The emergency brake control valve (32-45-02) is installed on the LH side of the pedestal and is manually operated to regulate emergency air pressure applied to the brake assemblies.

(2) The shuttle valves (32-45-01) consist of two (2) inlet ports, one (1) outlet port, and a shuttle. When pressure is applied at one (1) of the inlet ports, the shuttle will block off the other inlet port and allow flow through the outlet port.

2. Operation

A. To operate the emergency air brake system, the emergency brake control valve handle knob must first be pulled (away from quadrant) out of locked detent to unlocked detent. Lowering the emergency brake control valve handle admits high-pressure air to the hydraulic system shuttle valves. The shuttles seal off the hydraulic pressure side and admit high-pressure air through the open hydraulic line to apply brake pressure. Utilizing small movements of emergency brake handle, after braking action begins, will produce improved feel and reduce the probability of tire skid. When using emergency braking, anti-skid protection is not available. As the lever is raised, excess air pressure in the brake system is vented overboard while the valve closes against the emergency air pressure source. With the valve lever fully raised, push the knob forward (into quadrant) and into the locked detent.

NOTE: To restore to normal operation, bleed the brakes (Refer to 32-43-00, Servicing, Hydraulic Brake System) and recharge the bottle with dry air or nitrogen when the indicated pressure falls below the green line on the gage.

B. One (1) emergency air filter is installed in the emergency air pressure tee at the emergency brake control valve. On *Aircraft 35-028, 35-034 and Subsequent and 36-018 and Subsequent*, a second filter is installed 11 inches below the control valve in the emergency air brake line. (Inspect filters in accordance with the current inspection interval specified in Chapter 5.)

C. Shuttle valves isolate the hydraulic system from the emergency air system. During emergency brake application, air pressure exceeds hydraulic pressure and the shuttle in the valve repositions to admit air pressure to the brake assemblies. The shuttle valves will return to normal position when hydraulic pressure exceeds air pressure.

STEERING - DESCRIPTION AND OPERATION

1. Description

A. The variable authority nose wheel steering system is operable only when the aircraft is on the ground and either the pilot's or copilot's Control Wheel Master Switch (MSW) is depressed or the STEER LOCK Switch is engaged.

B. Nose steering turn angle varies with ground speed. At ground speeds of approximately 45 knots, steering travel is approximately 8°. Steering travel tapers inversely with ground speed to a maximum of 50° when ground speed is less than 10 knots.

C. A momentary steering lock switch energizes the steering lock circuit which applies a continuous 28 vdc to energize the nose wheel steering computer. Depressing a Control Wheel Master Switch (MSW) automatically removes the steering lock from the circuit.

D. System components consist of an electrically powered steering actuator and position sensor (follow-up) mounted on top of the nose gear strut, a steering computer-amplifier mounted in the right side of the nose section, a position sensor (followup) mechanically connected to the rudder pedals, two steering relays located on the forward side of frame 2 on the right side, a master switch on each control wheel, and a STEER LOCK Switch located on the trim switch panel. The system also utilizes the left inboard, right outboard, and right inboard wheel speed transducers to provide an input signal to the computer-amplifier. The system also utilizes the squat switch relay panel to provide the rudder pedal position sensor with an excitation voltage.

E. System power is 28 vdc for the actuator servo motor and 115 vac for the steering computer-amplifier.

F. *On Aircraft 35-071 thru 35-133 and 36-018 thru 36-034 and Aircraft 35-054 thru 35-070 when modified by AMK 76-3,35-002 thru 35-053 when equipped with Reduced Approach Speed System, and 36-002 thru 36-017 when equipped with Reduced Approach Speed System,* an interface adapter is installed electrically between the right hand outboard transducer, right hand inboard transducer, and left hand inboard transducer and the steering computer. The interface box is installed on the RH side of the nose wheel box at frame 3.

2. Operation (See Figure 1.)

A. On *Aircraft 35-002 thru 35-133 and 36-002 thru 36-034*, a one (1) vac excitation voltage is applied to the rudder pedal position sensor (followup) when the aircraft is on the ground and the squat switch relay panel is energized. Rudder pedal movement drives the rudder pedal position sensor which applies a voltage displacement signal to the nose steering computer-amplifier. The computer-amplifier applies a clockwise or counterclockwise signal to the steering actuator. Signal application causes the actuator clutch to engage the actuator motor. The clutch output torque drives the actuator gear train and positions the nose wheel to the selected position. As the actuator starts to rotate, a position sensor (followup) on top of the nose steering gear box applies a feedback signal to the computer- amplifier. The input signals from the left inboard, right inboard, and right outboard transducers modifies the rudder pedal position sensor signal to accomplish the degree of deflection in the steering system. The nose steering position sensor signal cancels the rudder pedal position sensor signal when the nose gear reaches its selected position.

On *Aircraft 35-071 thru 35-133 and 36-018 thru 36-034 and Aircraft 35-054 thru 35-070 when modified by AMK 76-3, 35-002 thru 35-053 when equipped with Reduced Approach Speed System, and 36-002 thru 36-017 when equipped with Reduced Approach Speed System*, an interface adapter box is installed. This adapter is electrically connected between the outputs of the left inboard, right inboard, and right outboard transducers and the steering computer-amplifier. The adapter is used to modify the input signals when the anti-skid system is being utilized.

B. On *Aircraft 35-134 and Subsequent and 36-035 and Subsequent*, a one (1) vac excitation voltage is applied to the rudder pedal position sensor when the aircraft is on the ground and the squat switch relay panel is energized. Rudder pedal movement drives the rudder pedal position sensor which applies a voltage displacement signal to the nose steering computer-amplifier. The computer-amplifier applies a clockwise or counterclockwise signal to the steering actuator. The steering actuator clutch is engaged whenever the MLG is down and locked through switch S6. As the actuator starts to rotate, a position sensor on top of the nose steering gear box applies a feedback signal to the computer-amplifier. The input signals from the left inboard, right inboard, and right outboard wheel speed transducers are applied to circuits in the computer-amplifier. The input signals are compared and then used to modify the rudder pedal signal (increase or decrease steering displacement). The nose steering position sensor signal cancels the modified rudder pedal position sensor signal when the nose gear reaches its selected position.

EXTENSION AND RETRACTION SYSTEM - DESCRIPTION AND OPERATION

1. Description

A. The landing gear extension and retraction system consists of the components necessary to extend and retract the landing gear, retain the gear in the up and locked position and open and close the gear doors.

B. The landing gear is extended by hydraulic actuators which contain internal locking devices to lock the gear in the down position. Hydraulic pressure is required to unlock and retract the landing gear.

C. The main gear doors and the nose gear shock strut are held in the up position by hydraulic pressure. In the event of hydraulic system failure, mechanical uplatch hooks hold the doors and gears up until the emergency extension system is activated. The uplatch hooks are normally released by uplatch actuators.

D. The nose gear doors and the outboard main gear doors are opened and closed mechanically through linkage connected to the shock strut. The main gear inboard doors are opened and closed by a hydraulic actuator.

E. In addition to normal gear extension, an emergency gear extension system is provided. The emergency gear extension system is controlled by an emergency gear control valve through shuttle valves.

F. Component Description

(1) The gear up switches are actuated by strikers mounted on top of the left and right landing gear trunnions. These switches energize the gear door control valve to the up position to close the main gear inboard doors. If these switches are not correctly adjusted, the main gear will retract but the inboard door will not close.

(2) The right gear down safety switch is actuated by a striker mounted on top of the right gear trunnion. This switch supplies continuous voltage to the landing gear selector valve which maintains the gear in its selected position.

(3) The left and right door down switches, one located on each main gear inboard door actuator, energize the gear selector valve to the up or down position after the main gear inboard doors are open. This allows the landing gear to extend or retract.

(4) The left and right main gear squat switches are located on each strut torque arm. When the aircraft is on the ground, the squat switches will:

(a) Complete a circuit to prevent the landing gear selector valve from energizing to the up position.

(b) Break a circuit that prevented aircraft landing with the brakes applied.

(c) Complete a circuit that energizes the squat switch relay panel.

(d) Enable the Stall Warning System Test Circuit.

(5) On *Aircraft 35-002 thru 35-066 and 36-002 thru 36-017*, the landing gear squat switch relay panel is located on the lower side of the RH floorboard between frames 13A and 14. On *Aircraft 35-067 and Subsequent and 36-018 and Subsequent*, the landing gear squat switch relay panel is located below the RH floorboard between frames 13B and 13C. Depending upon aircraft serial number, the following systems may be affected:

(a) Cabin pressurization and temperature control. (Refer to Chapter 21.)

(b) Autopilot system. (Refer to Chapter 22.)
(c) DC electrical power distribution. (Refer to Chapter 24.)
(d) Flight control systems. (Refer to Chapter 27.)
(e) Windshield anti-ice heat. (Refer to Chapter 30.)
(f) Gear extension and retraction system, and nose wheel steering system. (Refer to Chapter 32.)
(g) Aural warning system. (Refer to Applicable Chapters.)

NOTE: Simulating an air mode in the squat switch relay panel will be required during some maintenance practices. This is accomplished by pulling the SQUAT SW circuit breaker.

2. Operation

A. Landing Gear Down Cycle Operation (See Figure 1.)

(1) Setting the Landing Gear Selector Switch to DN energizes the gear door control valve to the down position. System pressure enters the valve and is directed to the door uplatch actuators and door actuators. Pressure unlatches the main gear door uplatches and opens the main gear inboard doors. When the uplatches open, the door up switches cause the gear indication red UNSAFE annunciators to illuminate. When the main gear doors are open, the door down switches are actuated and energize the landing gear selector valve to the down position. Pressure flows through the valve to release the nose gear uplatch actuator and extend the nose gear. The nose gear doors and main gear outboard doors are opened by mechanical linkage between the struts and the doors. Restrictors, installed in the main and nose gear actuator return lines, dampen gear extension. The restrictors have a free flow bypass feature in the opposite direction for rapid gear retraction. The nose gear down and locked switch illuminates the green LOCKED DN annunciator when the nose gear is fully extended and causes the UNSAFE annunciator to extinguish. When the main gear is extended, the main gear down and locked switches energize the gear door control valve to the up position and illuminate the green LOCKED DN annunciators. Pressure is routed to the door actuators and the main gear inboard doors close. The main gear inboard door uplocks are engaged by actuator spring tension. When the uplock mechanism is engaged, the door up switches are actuated and the left and right red UNSAFE annunciators extinguish. This completes the landing gear down cycle.

B. Landing Gear Up Cycle Operation (See Figure 2.)

(1) When the landing gear clears the ground on takeoff or when the aircraft is on jacks, the squat switches are actuated to allow the landing gear selector valve to be energized to the up position. Setting the landing gear selector switch to GEAR UP energizes the gear door control valve to the down position. System pressure enters the valve and is directed to the door uplock actuators and door actuators. Pressure unlatches the gear door uplocks and opens the main gear inboard doors. When the main gear inboard doors are opened, the door down switches are actuated and the landing gear selector valve is energized to the up position. Pressure flows through the valve to the nose gear and main gear actuators, causing the landing gear to retract. The nose gear doors and main gear outboard doors are closed by mechanical linkage. When the gear is retracted, the gear up switches are actuated, energizing the gear door control valve to the up position. Pressure is routed to the door actuators and the main gear inboard doors close. The nose gear and main gear inboard door uplatches are engaged by actuator spring tension. When the gear is fully retracted (all doors closed), the door up switches and nose gear up and locked switch are actuated, causing the red UNSAFE annunciators to extinguish. This completes the landing gear up cycle.

C. Landing Gear Down Cycle, Emergency Extension (See Figure 3.)

(1) The emergency air system to the landing gear and inboard main gear doors is operated by the emergency gear extension handle, located on the right side of the cockpit center pedestal. The emergency gear extension handle is recessed into the pedestal to prevent inadvertent actuation. When the handle is depressed, air from the emergency air bottle located in the nose cone is directed to the nose gear uplatch actuator, the main gear inboard door uplatch actuators, the nose gear actuators, the main gear inboard door actuators, and both main gear actuators. Shuttle valves, installed in the system, isolate the pneumatic system from the hydraulic system. After pneumatic extension of the landing gear, air pressure may be bled from the gear system through an overboard vent by inserting a finger into the hole in the pedestal just forward off the handle and pushing up on the ratchet release. This allows the spring-loaded handle to return to the of position.

THRUST REVERSER - MAINTENANCE PRACTICES

1. General

A. The thrust reverser system consists of two independently operated systems: one system functions to apply reverse thrust from the right engine, and the other functions to apply reverse thrust from the left engine. Each engine reverser installation consists of a throttle quadrant installation, Aeronca thrust reverser installation, and miscellaneous interface/joining components.

B. Power (28 vdc) for normal operation is supplied through the T/R CONT circuit breaker on the copilot's circuit breaker panel. Power (28 vdc) for emergency stow operation and position indicator lights is supplied through the T/R EMER STOW and T/R POSN IND circuit breakers.

C. The thrust reverser system includes automatic stow and stow prevention features which reduce the possibility of asymmetric thrust occurring either in-flight or on the ground. The automatic stow feature activates the stow cycle in the event of a pneumatic latch failure. The stow prevention feature keeps either thrust reverser from stowing while the other is in reverse thrust mode.

2. Description

A. With the NORM-EMER STOW Switch on the thrust reverser control panel in the NORM position, the throttle quadrant provides all necessary controls to operate the system. The reverser levers are pivoted on the main thrust levers, and control system operation through stow, deploy, and reverse thrust operations when the main thrust levers are in the IDLE position. A throttle control interlock switch, solenoid, and pawl, incorporated in the control quadrant assembly, prevent application of reverser thrust above approximately 45% N1 rpm until both thrust reversers are fully deployed. With the NORM-EMER STOW Switch in the EMER STOW position, the ignition switches in the throttle quadrant installation and the thrust reverser emergency stow cutout box prevent completion of emergency stow circuits above approximately 70% N1 rpm.

B. The bleed air supply system provides bleed air from the engine high pressure compressor to drive the air motor in the pneumatic actuator assembly and operate the pneumatic latches.

C. The electrical wiring installation is composed of the squat switch relay panel, thrust reverser control panel, throttle quadrant switches, thrust reverser relay panel, thrust reverser relay box, and thrust reverser emergency stow cutout box.
   (1) The squat switch relay panel prevents normal operation of the thrust reverser system until the squat switches are in the ground mode.
   (2) The thrust reverser control panel, located on the glareshield, provides the crew with visual indication of system operation and normal or emergency mode selection.
   (3) The throttle quadrant assembly contains two switches for each thrust reverser system. One switch arms the system when the main thrust levers are moved to the IDLE position and the other completes deploy circuits when the thrust reverser levers are pulled to the deploy position, or completes stow circuits when the thrust reverser levers are moved to the stow position. The throttle quadrant installation also contains ignition switches which, in addition to their normal functions, prevent completion of emergency stow circuits unless the main thrust levers are below a position corresponding to approximately 70% N1 rpm. A mechanical interlock secures the thrust reverser levers in the stowed position with the main thrust levers in any position other than idle.

(4) The thrust reverser relay panel is located on the left side of the aircraft just forward of frame 26 and is attached to stringers 13 and 14. The panel contains the necessary relays for normal operation of the thrust reverser system.

(5) The thrust reverser relay box is located immediately left of the aircraft centerline just forward of frame 27. The box contains relays which, when activated during thrust reverser deploy and stow cycles, interrupt circuits for windshield anti-ice, nacelle heat, wing heat and stabilizer heat.

(6) The thrust reverser emergency stow cutout box is attached to the inside of the LH pedestal panel. The cutout box and the ignition switch in the throttle quadrant installation prevent completion of emergency stow circuits above approximately 70% N1 rpm.

3. Operation (See Figure 1.)

A. The thrust reversers are commanded to translate by proper positioning of the main and thrust reverser levers located in the throttle quadrant when the aircraft is on the ground.

(1) With the thrust reverser control system circuit breakers engaged and the Normal/Emergency Stow Switch in “NORM,” 28 vdc is applied to the squat switch relay panel, the source side of the Bleed Valve Test Switch, and to the thrust reverser pneumatic latch switches (B) contacts.

(2) Engaging the thrust reverser position indicator circuit breaker supplies 28 vdc to the (C) contacts of the pneumatic latch switches.

(3) With weight on the gear, the closed squat switch applies 28 vdc to the main thrust levers “IDLE” arming switches in the Throttle Quadrant, and to the throttle interlock relay in the thrust reverser relay panel.

(4) 28 vdc is also routed through the Thrust Reverser Control relay switches to the “STOW” side of the airmotor. The thrust reversers remain in the stowed and locked position until the pilot initiates a deploy command.

(5) With the main throttle levers in the “IDLE” position and the thrust reverser thrust levers in the deploy position, electrical circuits are completed through the Idle Arming Switches in the throttle quadrant to the deploy side of the reverser control relay within the Thrust Reverser Relay Panel Box.

NOTE: Electrical power to deploy the thrust reversers will not be available unless both thrust reverser levers are in the deploy position.

(6) When both reverser control relays are energized to deploy, electrical power is routed to the pneumatic latch control valves, to the deploy coil of the directional control valve and air-on-valve in the thrust reversers. The thrust reverser translates to deploy.

NOTE: When the pneumatic latches are energized, electrical circuits are completed to illuminate the “UNLOCK” lights on the control panel.

Bleed air supply to the windshield heat, wing/stabilizer heat, and nacelle heat is shut off during the deploy and stow cycles (approximately 3 seconds.)

(7) When the thrust reversers are fully deployed (approximately 2 seconds) the deploy limit switches are actuated and complete an electrical circuit to (1) energize the L/R throttle release solenoid

control relay in the thrust reverser relay panel, and (2) energize the “DEPLOY” light and extinguish the “UNLOCK” lights on the control panel.

NOTE: Both the left-hand and right-hand deploy limit switches must be actuated in order to complete the circuit to the L/R throttle release solenoid.

(8) When the throttle release solenoid is energized, the thrust reverser lever locks are released which allows the crew to apply increasing reverser thrust.

NOTE: Excessive force applied to the thrust reverser levers, while the throttle lock is still engaged, will prevent the throttle lock from releasing and reverse thrust above 60% N1 will not be available.

(9) As reverse thrust is applied, a pressure switch in the thrust reverser is actuated when engine bleed air pressure reaches 50 psia during engine acceleration. Actuating the pressure switch completes a circuit to illuminate the “BLEED VALVE” light on the control panel.

NOTE: The “DEPLOY” and “BLEED VALVE” lights will remain illuminated until a stow command is initiated.

B. The thrust reverser system incorporates an indicator system to warn the crew, by means of a flashing unlock light, if the thrust reversers should stow with the blocker doors inside the fan duct.

C. *On Aircraft 35-439 thru 35-500, 35-506, 36-051 thru 36-053, and prior aircraft modified per AMK 81-6A, “Installation of Thrust Reverser Blocker Door Position Indicator,”* the UNLOCKED light is an amber flashing light.

D. A test switch located on the thrust reverser control panel is used to test the bleed valve and the door position indicator circuits prior to takeoff or landing. When the test switch is depressed and held to TEST, the bleed valve light will illuminate and the UNLOCKED (amber) light will flash.

E. A diagnostic circuit is included in the door position indicator installation to sense a failure of the door position switches. A relay is wired into the circuit which will cause the UNLOCKED light to remain illuminated when the deploy light is on in the event of a switch malfunction.

F. The Normal/Emergency Stow switch mounted on the thrust reverser control panel must be in the “NORMAL” position for all normal operations. When EMER STOW is selected, electrical power is removed from both normal systems and power is applied from a separate circuit breaker directly to both air-on-valves and pneumatic actuators to stow the system.

G. To protect the flexible drive cables, a 70% RPM cutout switch in the throttle quadrant prevents a stow signal to the system until the main thrust levers are retarded below 70% N1 RPM. A switch position light is incorporated to warn the crew that the Normal/Emergency Switch is in EMER STOW position, and that the thrust reversers will not operate while the light is on.

H. For more detailed operation of the thrust reverser components, refer to Aeronca Maintenance Manual, Publication No. 78-30-00.