GYROSCOPIC PRECESSION

The spinning main rotor of a helicopter acts like a gyroscope. It has the properties of gyroscopic action, one of which is precession. Gyroscopic precession is the resulting action occurring 90 degrees from the applied force. A downward force to the right of the disc area will cause the rotor to tilt down in front. This action is true for a right-to-left (counterclockwise) turning rotor. The cyclic control applies force to the main rotor through the swashplate.

To simplify directional control, helicopters use a mechanical linkage that places cyclic pitch change 90 degrees ahead of the applied force. Moving the cyclic control forward will cause high pitch on the blades to the pilot's left. At the same time, low pitch occurs on the blades to his/her right. This combina-tion of forces results in the rotor tilting down in front. If not for this offset linkage, the pilot would have to move the cyclic stick 90 degrees out of phase. In other words, the pilot would have to move the stick to the right when attempting to tilt the disc forward. He/she would move the cyclic stick forward when attempting to tilt the disc area to the left, and so on.

GROUND EFFECT

Ground effect can be achieved when a helicopter is in a hover or forward flight while in close proximity to the ground or some other hard flat surface. When a helicopter is in a hover or moving slowly, the main rotor is developing thrust that is being vectored, or directed down toward the surface. The surface resists this airflow (thrust) by building up air pressure between the rotor and the surface, thus providing ground cushion. When the helicopter is in forward flight, the cushion is not as great as the thrust that is being vectored down and aft of the helicopter. This ground cushion will provide additional lift without additional power, and will be apparent when the helicopter is hovering or flying at an altitude of approximately one-half the main rotor diameter or below. The closer the helicopter is to the ground, the greater the cushion effect. This will be indicated by the reduced power required to maintain flight or hover. The maximum cushion effect is achieved at zero airspeed.

TRANSLATIONAL LIFT

As a helicopter begins the transition from a hover to forward flight, at approximately 10-15 knots, it will experience a loss of lift and settle slightly and seem to loose power, without an actual reduction in power. This is due to the loss of the ground cushion caused by the changing direction or vector of the rotor's thrust. As the helicopter continues to accelerate, the rotor will be introduced to larger masses of air. The rotor will become more efficient and the thrust vector of the rotor will become more stable. Without increasing power (thrust), the helicopter will begin to climb and continue to accelerate. This changing relationship of power (thrust) available and power required is called "translational lift." The speed that a helicopter passes out of translational lift into forward flight can vary, but generally it is equal to approximately one-half the rotor diameter in knots, or approximately 25 knots for a 50-foot diameter rotor.

AUTOROTATION

Autorotation occurs when the main rotor rotates by air passing up through the rotor system instead of by the engine. The rotor disengages automatically from the engine during engine failure or shutdown. During autorotation, the rotor blades turn in the same direction as when engine driven. The air passes

up through the rotor system instead of down. This action causes a slightly greater upward flex or coning of the blades.

POWER SETTLING

Stalling, as applied to fixed-wing aircraft, will not occur in helicopters. However, power settling may occur in low-speed flight. Power settling is the uncon-trollable loss of altitude. This condition may occur due to combinations of heavy gross weights, poor density conditions, and low forward speed. During low forward speed and high rates of descents, the downwash from the rotor begins to recirculate. The downwash moves up, around, and back down though the effective outer disc area. The velocit y of this recir-culating air mass may become so high that full collec-tive pitch cannot retard or control the rate of descent.

TYPES OF HELICOPTERS

Learning Objective: Identify the two basic types of helicopters and recognize the advantages of each.

Two basic types of helicopters are the single-rotor and multirotor types. The single main rotor with a vertical or near vertical tail rotor is the most common type of helicopter. The SH-60 and SH-2, shown in figure 10-5, are examples of single-rotor helicopters.



Figure 10-5.-Representative types of naval helicopters.

Multirotor helicopters fall into different groups according to their rotor configuration. The CH-46, shown in figure 10-5, is a multirotor helicopter of the tandem rotor design. The single-rotor configuration requires the use of a vertical tail rotor to counteract torque and provide directional control. The advantages of this con-figuration are simplicity in design and effective directional control. In the tandem rotor design, one rotor is forward of the other. Sometimes the rotor blades are in the same plane. They may or may not intermesh. The design offers good longitudinal stability since lift occurs at two points, fore and aft. The tandem rotor has little torque to overcome because these rotors rotate in opposite directions.

HELICOPTER FLIGHT CONTROLS

Learning Objective: Identify the three primary flight controls and the basic control systems components.

Helicopter flight controls differ drastically from those found in fixed-wing aircraft. Helicopter flight controls consist of both cyclic and collective pitch control systems and the rotary rudder flight control system.

The hydraulically powered flight control mechanism, shown in figure 10-6, provides you with an example of systems common to most helicopters. These are the systems on which you will most likely be working. Fairly exact values, such as tolerances, pressures, and temperatures, are given to provide instructive coverage. When actually performing the maintenance procedures, consult the current technical publications for the latest information and exact values.

CYCLIC PITCH CONTROL SYSTEM

The cyclic pitch control system provides the means of controlling the forward, aft, and lateral movements of the helicopter. Movement of the pilot's or copilot's c yclic stick transmits through control rods and bell cranks. This movement is sent to the auxiliary servo cylinders, the mixing unit, and three primary servo cylinders. These primary servo cylinders control movement of the rotary-wing blades.

The cyclic system has a stick trim system that hydraulically operates the controls for automatic flight. During automatic flight, trim movements are controlled manually by the cyclic stick grip switch. The switch is overridden for major control changes by stick movement.

Moving the cyclic stick forward extends the aft primary servo cylinder and retracts the forward primary servo cylinder. Aft movement of the cyclic stick extends the forward primary servo cylinder and retracts the aft primary servo cylinder. In both cases, the helicopter will advance in the direction of stick movement. Movement of the stick laterally will move the helicopter right or left, corresponding with stick movement. This movement occurs by retracting and extending the left and right lateral primary servo cylinders.

COLLECTIVE PITCH CONTROL SYSTEM

The collective pitch control system provides vertical control of the helicopter. Movement of the collective pitch control stick is sent through control rods and bell cranks to the appropriate auxiliary servo cylinder. Movement is sent from the servo cylinder to the mixing unit. At the mixing unit, all vertical movements of the collective sticks are sent to the primary servo cylinders and the rotary-wing swashplate. At this point, the pitch of all blades increases or decreases equally and simultaneously. A balancing spring attaches to the control rods to help balance the weight of the collective stick. A friction lock on the pilot's collective stick applies the desired amount of friction to the tube of the collective stick. The lock prevents creeping during flight. It also provides feel for the pilot when operating the controls. The friction is applied by rotating the serrated handgrip on the collective stick to its stop. The grip of each collective stick contains several switches that are labeled for the function they control. In the automatic stabilization equipment (ASE) mode operation, the collective pitch operation controls through the auxiliary servo cylinder.

ROTARY RUDDER CONTROL SYSTEM

The rotary rudder control system controls the pitch of the rotary rudder blades. The blades control the heading of the helicopter. The pedals control the system through a series of control rods and bell cranks. These units connect to the directional bank of the auxiliary servo cylinder and the mixing unit. See figure 10-6. At the mixing unit, a control rod operates the forward quadrant. This quadrant connects by



Figure 10-6.—Flight control systems.

cable to the aft quadrant. A control rod from the rear quadrant connects to the control rods, bell crank, and pitch control shaft. These parts are found in the rotary rudder tail gearbox. A hydraulic pedal damper is located in the auxiliary servo cylinder bank (directional). Its purpose is to prevent sudden movements of the control pedals. The damper prevents rapid changes in blade pitch, which might cause damage to the helicopter. As on conventional aircraft, the rudder pedals are adjustable for different leg lengths. The rotary rudder system operates by manual input or automatically by input from the ASE. The negative force gradient spring cancels feedback loads exerted by the rotary rudder during flight. It also cancels feedback loads when the auxiliary hydraulic system is off. When the rotary rudder is stationary, an initial force is required to move either pedal from its extreme position. With the auxiliary hydraulic system on, the effect of the negative force gradient spring is zero.

WARNING

The negative force gradient spring is preloaded to 600 pounds. To prevent injury to personnel or damage to flight controls, carefully follow the maintenance instructions provided in the MIM.

FLIGHT CONTROL SYSTEMS

COMPONENTS

The basic components of the helicopter flight control systems are the auxiliary servo cylinder, the mixing unit, the primary servo cylinders, and the swashplate.

Auxiliary Servo Cylinder

This cylinder consists of four separate banks of servomechanisms constructed as a unit. Figure 10-7 shows the fore-and-aft bank of the servo cylinder. The other banks are similar in design and operation, except as noted in the following paragraphs. The hydraulic power pistons of each bank help flight control movements before the movement is sent to the mixing unit. The cylinder operates on mechanical input during manual operation of the flight controls. The cylinder operates on electrical input from the ASE, and on electrical input from the stick trim system.

Each of the four banks operates in a single area of control functioning, providing fore-and-aft, lateral, collective, and directional hydraulic aid. Each bank has a mechanical and electrical input hydraulic servo valve capable of displacing the pilot valve shuttle for ASE operation. Additionally, the fore-and-aft and the lateral banks have a pair of solenoid-operated stick trim valves. These valves control fore, aft, and lateral movements through the stick trim system.



Figure 10-7.—Auxiliary servo cylinder.

The directional bank uses a pedal damping piston that restricts sudden heading changes. The auxiliary servo cylinder operates at 1,500-psi hydraulic pressure supplied by the auxiliary hydraulic system.

Mixing Unit

The mixing unit consists of a system of bell cranks and linkage. The unit coordinates and transfers independent movements of the lateral, forward, aft, and directional controls. Movement is sent to the primary servo cylinders and the rotary rudder. The mixing unit also integrates collective pitch control movements with those of the lateral, fore-and-aft, and directional systems. It causes the controls to move the three primary servo cylinders simultaneously in the same direction. It changes the pitch on the rotary rudder blades to compensate for the change in pitch of the rotary-wing blades.

Primary Servo Cylinders

These three servo cylinders send flight control movements to the stationary swashplate of the rotarywing head. If the primary hydraulic system is operating, the servo cylinders hydraulically aid flight control movement. If the power fails, they function only as control rods. See figure 10-8. This is accomplished by the spring-loaded bypass valve, which prevents hydraulic lock and a sloppy link pilot valve connection. The pilot valve and the lower clevis of the power piston connect to the flight control linkage by the same bolt. There is a very close tolerance in the pilot valve connection. This tolerance causes the pilot valve to operate before the power piston clevis. The power piston is then mechanically displaced.

Fluid under pressure entering the servo cylinder upper port closes the bypass valve and enters the upper chamber. With the pilot valve in neutral, fluid cannot escape from the lower chamber, and the piston remains motionless. If the pilot valve moves upward, fluid flows into the lower chamber. The

piston will rise because of a pressure area differential. If the pilot valve moves down, the fluid in the lower chamber flows to return. The piston will be forced downward by upper chamber pressure.



Figure 10-8.—Primary servo cylinder.

When flight control movements stop, the piston will continue to move until the ports of the pilot valve close. The pilot valve clevis will be in the center of the sloppy link. When pressure is off, the bypass valve will open, preventing hydraulic lock.

Swashplate Assembly

The swashplate assembly, shown in figure 10-9, sends movement of the flight controls to the rotarywing blades. A ball ring and socket allows the swashplate to tilt off of its horizontal plane and move on its vertical axis.

The assembly consists of a rotating swashplate, connected to the rotary-wing hub by the rotating scissors and adjustable pitch control rods. The assembly also has a stationary swashplate, which connects to the main gearbox by the stationary scissors and the primary servo cylinders. Each swashplate assembly is bolted together in a way that permits the rotating swashplate to rotate within the





Figure 10-9.—Swashplate—cross-sectional and installed view.

stationary swashplate. When the primary servo cylinders are actuated by the flight controls, the stationary swashplate moves, with this movement being transmitted to the rotating swashplate. The rotating swashplate sends movement, through the adjustable pitch control rods, to the sleeve spindle of the rotary blades. This action changes the angle of incidence of the blades.

ROTARY-WING MAINTENANCE

Learning Objective: Recognize general rotary-wing maintenance procedures to include system rigging and rotor blade tracking.

Organizational maintenance of the helicopter flight control system includes periodic inspection, lubrication, rigging, and blade tracking. It also includes the cleaning of the rotary-wing and rudder blades and the removal and replacement of malfunctioning components.

Organizational maintenance of the auxiliary and primary servo cylinders is limited to minor adjustment and replacement of miscellaneous seals.

Organizational maintenance includes the removal and installation of the complete component. Major adjustments made on servo cylinders during overhaul are critical. These adjustments are not made at the lower levels of maintenance.

Vibrations and cyclic actions inherent to helicopters can cause component or structural fatigue. Nondestructive testing (NDI) is used on many parts of the airframe and many dynamic components to detect flaws (cracks) that could lead to failure. Additionally, most of the dynamic components, such as rotor heads, blades, servo cylinders, and swashplates, have forced (high-time) removal intervals. These time intervals are listed by component in the Periodic Maintenance Information Cards (PMIC) for the aircraft.

You should clean the rotary wing and rotary rudder as necessary, using only approved cleaners. The concentration of mixture will vary, depending on the surface condition and type of cleaner used.

CAUTION

Both the rotary-wing and rudder blades have areas that connect by bonding adhesives or are manufactured out of fiber glass or advanced composite materials. Never use solvents or cleaners not specifically authorized in the MIM. Do not use lacquer thinner, naphtha, carbon tetrachloride, or other organic compounds for cleaning in these bonded areas. Use of these solvents or cleaners may result in blade failure.

SYSTEM RIGGING

Rigging checks and adjustments involve the cyclic pitch control stick, collective pitch control stick, and pedal positions. These controls must coordinate with the correct rotary-wing and rotary-rudder blade angles. You must be sure that the flight controls are operating under normal friction loads.

The use of rigging pins and other rigging aids provide proper rigging and proper system operation. Each step outlined in the MIM should be carefully performed.

Several quick rigging, cable adjustment, and operational checks with related maintenance precautions are found in the MIM. No attempt to duplicate this information is provided in this chapter. The MIM should be consulted before any mainte-nance begins.

At the completion of rigging, a flight test must be performed by a qualified pilot. A flight check chart is provided by the MIM. The MIM lists the conditions of the check, the required performance, and information to aid in the correction of malfunctions.

ROTOR BLADE TRACKING

You must perform blade tracking when rerigging the helicopter. Tracking is necessary when the blades, the main gearbox, or the main rotor head assembly have been replaced. Unless the blades arc in proper track, vibrations will occur in the helicopter with every revolution of the main rotor. At high rpm settings, these vibrations could cause serious struc-tural damage.



Figure 10-10.—Blade tracking—Strobex.

Tracking the blades is necessary to be sure that the blades rotate in the same horizontal plane (track). This is accomplished by pretrack rigging of the rotary-wing head and by the use of pretracked blades. Pretrack rigging involves adjusting the pitch control rods until an exact sleeve angle (within 1 minute) is found on all sleeve spindles. A micrometer type of decal is affixed to the adjustable pitch control rods as a permanent reference at the overhaul activity. A pretrack number is stenciled on each blade at the time of manufacture or overhaul. This number is based on the effective angle of the blade. Install prctracked blades on the helicopter by setting the adjustable pitch control rod to the pretrack number stenciled on the blade.

If the pretrack number is MINUS and the pitch control rod decal shows the setting is zero, loosen the locknut. Shorten the rod by rotating the tang clockwise. Keep rotating until it aligns (closest notch) with the appropriate blade pretrack number on the lower scale of the lower decal. Engage the tang by tightening the locknut. If the pretrack number of the blade is PLUS and the pitch control rod decal shows the setting is zero, loosen the locknut. Lengthen the rod by rotating the tang counterclockwise. Keep rotating the tang until it aligns (closest notch) with the appropriate blade pretrack number on the locknut by rotating the tang counterclockwise. Keep rotating the tang until it aligns (closest notch) with the appropriate blade pretrack number on the upper scale of the lower decal. After adjusting the remainder of the pitch control rods, tighten the locknuts to the torque specified in the MIMs. Safety wire the locknuts to the tang.

You should perform a ground operational check. With the rotary-wing head engaged, operate the engines at 100 percent. Check for vibrations in the rotary-wing head. If vibrations occur and the adjustable pitch control rods were properly adjusted, use an alternate method of blade tracking. In this case, use a strobe blade tracker to check the blades under actual operating conditions. You must be sure that all blades are rotating in the same horizontal plane. See figure 10-10. Pitch adjustment of each blade may be made to compensate for blade differences.

The Strobex blade tracker permits tracking from inside the helicopter in flight or on the ground. The system uses a highly concentrated stroboscopic light beam flashing in sequence with rotation of the rotary-wing blades, so that a fixed target at the blade tips will appear to be stopped. A soft iron sweep attached to the rotating swashplate passes close to a magnetic pickup attached to the stationary swashplate, causing a once-per-revolution pulse, which synchronizes the lamp flash rate with the rotation of the blades. Each blade has a retroreflective target number attached to the underside of the blade in a uniform location. Tracking of each blade is then determined by the relative vertical position of the fixed target numbers. See figure 10-10. Consult the applicable aircraft MIMs for the proper operating procedures for the Strobex blade tracker. For maintenance infor-mation on the Strobex tracker, refer to NAVAIR 17-15BBA-4.

NOTE: Do not adjust blades by the Strobex method of blade tracking unless problems result from normal tracking procedures.

ROTOR BRAKE SYSTEM

As a part of the blade folding operation, the rotor brake applies manually or automatically. The system is shown in figure 10-11. It consists of a rotor brake assembly, panel package, accumulator, master cylinder, pressure gauge, check valves, and pressure switches.

Rotor Brake Assembly

The rotor brake assembly is comparable to the single disc wheel brake in its design and operation. Hydraulic actuation of the brake may be made manually by using the rotor brake master cylinder located in the cockpit. The brake applies automatically during the blade folding operation by the blade positioner control valve. In manual operation, the brake is capable of stopping the rotary-wing head in 14 seconds from 157 rpm. Replace the brake linings when any of the adjusting pins recede into the adjusting nut 1/8 inch. Replace lock screws and worn parts each time linings are replaced.

Rotor Brake Panel Package

This package consists of an accumulator, relief valve, pressure reducer, and a shuttle valve. The package receives hydraulic pressure from the master brake cylinder during manual operation. It receives pressure from the automatic blade folding system during automatic operation. When the master brake cylinder handle is in the OFF or DETENT position, the master cylinder vents to the utility fluid tank. Movement of the master brake cylinder handle blocks





Figure 10-11.—Rotor brake and system schematic.

the vent and builds up brake pressure. When the pressure increases beyond 200 psi, the shuttle valve in the panel package shifts. Pressure is sent to the rotor brake and blocks pressure from the automatic blade folding system. The panel package accumulator reduces minor pressure surges during manual and automatic operation. The accumulator maintains a steady pressure to the brake. The relief valve relieves pressure surges in excess of 600 psi.

Rotor Brake Accumulator

The spring-loaded rotor brake accumulator permits manual operation of the master cylinder handle during automatic blade folding operations. Applying the automatic brake unseats the accumulator sequence valve. The open valve permits actuation of the master cylinder handle. The hydraulic fluid flows through the sequence valve and compresses the accumulator spring. Releasing the automatic brake causes pressure to flow from the accumulator to the panel package shuttle valve, and repositions it. Simultaneously, the panel package accumulator maintains hydraulic pressure that was trapped from the automatic application in the rotor brake. The rotor brake accumulator additionally compensates for thermal expansion and contraction of the fluid, and aids in dampening pressure surges.

Rotor Brake Master Cylinder

The master cylinder is gravity fed by hydraulic fluid from the utility fluid tank. Move the brake handle down and forward to apply pressure to the system. A spring latch on the cylinder linkage automatically locks the handle in the ON or PARK position. To release the brake, pull the latch and place the handle in the DETENT position. The pressure gauge indicates the amount of pressure produced by the master brake cylinder. The check valve provides a means to pressure bleed the system. A minimum pressure of 320 psi is required to effectively operate the rotor brake.

AUTOMATIC BLADE FOLDING SYSTEM

An automatic blade folding system of a representative helicopter is shown in figure 10-12. This system is capable of automatic blade folding of one of the two rotary blades from cockpit controls.

Blade Folding Operations

The No. 1 blade does not fold, but it automatically positions over the tail pylon. The only hydraulic actuation of the No. 1 blade is damper positioning. The hydraulic portion of the system positions the blades and folds the No. 2 blade. The electrical portion of the system provides the sequencing of operation of the various hydraulic components. It acts to prevent accidental operation of the system. Warning and indicating lights show the status of the system at all times. Safe operation is maintained by a series of electrical interlocks.

You should perform blade folding operations with the pylon locked in the flight position and the engine operating at 104 percent. The rotary-wing head must not be operating. The accessory drive switch is placed in ACCESS DRIVE. The safety valve switch is placed OPEN, and the master switch is placed ON. The blade switch is placed in the FOLD position. Hydraulic pressure from the utility hydraulic system is 3,000 psi. The pressure flows through the motor-operated safety valve. This pressure flows to the blade positioner control valve, and is sent to the blade positioner drive unit for engagement with the rotor brake disc. This action turns the rotary-wing shaft.

Pressure is sent through the blade rotation control valve to the blade positioner hydraulic motor. The motor revolves the blade positioner, causing the rotation of the rotary-wing head. When the No. 1 blade is properly positioned aft, the blade positioner control valve is energized in the opposite direction. The action stops positioning and disengaging of the blade positioner drive unit. Fluid is also sent to engage the rotor brake at this time.

On later models, the rotor brake applies manually. The blade fold control valve is energized, sending hydraulic pressure through the rotor coupling to each damper-positioner. The blades move against their autorotative stops. The mechanical action of positioning the blades operates the damper-positioner sequence valves. These valves cause hydraulic fluid to operate the control lock cylinder, locking the controls. With the rotor head controls locked, pressure is sent to the blade fold lock cylinder. The lockpin is retracted, and fluid is sent to the blade fold cylinder.





Figure 10-12.—Automatic blade folding system schematic.





Figure 10-12.—Automatic blade folding system schematic—Continued.

The blade fold cylinder is found inside the sleeve spindle of the No. 2 blade. See figure 10-13. It connects to sector gears, which cause the folding actions. When the No. 2 blade reaches a certain angle, a microswitch turns on the blade folded light in the cockpit. The lock valve traps hydraulic fluid in the rotary-wing head to keep the damper-positioners in the autorotative position. It also keeps the No. 2 blade in the folded position.

With the fold sequence completed, the SAFETY VALVE OPEN, the FOLD PWR ON, the No. 1 BLADE POS, the CONT LOCKPIN ADV, and the BLADES FOLDED warning and indicating lights are lit.

NOTE: You may have to move the cyclic control stick around the neutral position to engage the control lockpin. If excessive movement of the cyclic stick is necessary, troubleshoot the system for possible mal-adjustment.

Blade Spreading Operations

The spreading operation requires the same conditions as the fold operation. The primary exception is that the blade fold switch is in the SPREAD position. Pressure is sent through the motor-operated safety valve and through the positioning unit pressure reducers. Pressure is sent to the blade positioner drive unit for rotor brake disc disengagement and the engagement of the rotor brake. With the rotor brake on and the blade fold valve energized, 3,000 psi hydraulic fluid is sent through the rotor coupling. From the coupling, pressure is sent to the damper-positioners. The damper-positioners drive the blades against their autorotative stops. Pressure is then sent to the blade fold cylinder. The blade fold cylinder operates the gear sector and spreads the blade. As the blade starts to spread, the lock valve solenoid is de-energized, releasing fluid in the rotary-wing head.

When the blade is completely spread, hydraulic fluid is sent to the blade lock cylinder, engaging the blade lockpin. Engagement and locking of the blade lockpin causes the internal sequencing mechanisms to direct pressure to the control lock cylinder. The control lock cylinder, in turn, locks the controls. The spread sequence is completed. The FOLD PWR, BLADE SPREAD, and SAFETY VALVE OPEN warning and indicating lights should be lit.



Figure 10-13.—Blade fold cylinder.

Blade Folding System Components

Hydraulic components of the blade folding system are conventional type, solenoid-operated selector valves, check valves, pressure reducers and snubber, sequence valves, and actuating cylinders. Of special interest are the safety valve, the blade positioner drive unit, the rotor coupling, the control lock cylinder, and the blade fold accumulator.

SAFETY VALVE.— The safety valve is a two-position, motor-operated selector valve. The purpose of the unit is to prevent hydraulic pressure from entering the blade fold system during flight. The motor provides a camming action to move the poppet valve within the selector valve. With the rotor stopped, electrical interlocks allow the safety valve to send fluid to the blade folding system. This action occurs when the safety valve switch is placed in the OPEN position. In the CLOSED position, pressure is blocked at the pressure port. The system vents through the lock valve. The venting eliminates the possibility of damage to the system by thermal expansion of the hydraulic fluid. The safety valve will not close if the blade spread interlock relay malfunctions. The safety valve will not close if the blades are folded. The safety valve motor opens a limit switch. The switch cuts electrical power to the motor when the safety valve reaches the fully open position.

BLADE POSITIONER DRIVE UNIT.— The drive unit is found on the upper surface of the main gearbox input cover. It consists of a gear train, a sequence valve, a tiller plug, a sight gauge, and a hydraulic motor. The gear train rotates because of the hydraulic motor. The gear train turns the rotary-wing head by running the rotor brake disc. The hydraulic disc motor operates only after the gear train engages the teeth of the rotor brake disc. Pressure is cut off to the blade rotation control valve and the motor by the sequence valve. This action occurs when the gear train has been operated to disengage the rotor brake disc.

ROTOR COUPLING.— The rotor coupling is found at the bottom of the rotary-wing shaft. It serves to transfer hydraulic fluid to the rotary-wing head for blade folding. Figure 10-14 shows a cross-sectional view of the coupling. The coupling consists of a spindle that revolves with the rotary-wing shaft. A stationary housing connects to hydraulic lines of blade folding components. Hydraulic fluid is sent through the rotor coupling, and then through the lock valve. Pressure is then sent to the manifold, to the damper-positioner shuttle valve, and to the damper-positioner sequence valves.

CONTROL LOCK CYLINDER.— The control lock cylinder is on the No. 2 blade horn assembly rotary-wing head. During the fold cycle, the control lock cylinder locks the flight controls. This occurs only after the blade has been positioned. During the spread cycle, it unlocks the controls. A microswitch within the housing of the cylinder causes the CONT LOCKPIN ADV advisory light in the cockpit to light. In event of hydraulic malfunction, the control lockpin may be operated manually. This is done by turning a sector gear bolt on the aft end of the cylinder. The sector bolt rotates gear teeth on the end of the actuating piston shaft.

BLADE FOLD ACCUMULATOR.— A blade fold accumulator is found inside of the rotary-wing sleeve of the No. 1 blade. It has a preload of 1,500-psi nitrogen pressure to maintain hydraulic pressure in the rotary-wing head. The pressure is necessary to keep the damper-positioners extended and the blade locked in the folded position. It serves to compensate for expansion and contraction of the hydraulic fluid because of temperature changes. It also dampens out pressure surges during fold and spread cycles.

AUTOMATIC BLADE FOLDING SYSTEM MAINTENANCE

Maintenance of the blade fold system consists of periodic inspection, lubrication, operational testing, and troubleshooting. Allowable maintenance at the organizational level includes alignment, adjustment, and the removal and installation of components. Parts



Figure 10-14.—Rotor coupling.

replacement and cure date kits are available for intermediate-level repair of defective parts. Before removal of any component, secure the blades to prevent damage. Whenever any part of the system is repaired or replaced, the electrical portion of the system should be tested, as required by the MIM. Operationally check the entire hydraulic portion of the system to ensure proper sequence of operation. The hydraulic testing procedures discussed in the following paragraphs are used as an example. Always consult your MIM for correct procedures.

Charge the air accumulator with 1,500 psi of nitrogen, with the blades in the spread position. Connect a source of external hydraulic power to the utility, primary, and auxiliary hydraulic systems. Set pressure to 3,000 psi at approximately 3 gallons per minutes for the utility system. Set pressure to 1,500 psi for the primary and auxiliary servo hydraulic systems. Position the ACCESSORY DRIVE switch to ACCESS DR. The accessory drive light will light. At the start of the testing, make sure that

PRI SERVO PRESS, AUX SERVO PRESS, ACCESSORY DRIVE, ROTOR BRAKE ON, and CHECK BLADE FOLD lights will light. The ACCESSORY DRIVE, FLIGHT POS, BLADE SPREAD, EXT PWR ON, PRI SERVO PRESS, and AUX SERVO PRESS lights should be lit. Visually check to see that the lockpins are disengaged. Manually rotate the rotary head until the leading edge of the No. 1 blade is in the aft position. Engage the rotor brake. The rotor brake pressure gauge should read a minimum of 320 psi. Check that the rotor brake light comes on. Place the collective pitch stick in the full low position and the cyclic pitch stick in neutral. Visually examine the control lock cylinder to make sure that the pin is aligned with its hole. When the controls are positioned, trip the FOLD manual override on the blade fold control valve and hold it in this position. No action should result. Release the override. Position the SAFETY VALVE switch to OPEN. Check that the SAFETY VALVE OPEN light comes on. Trip the manual override again. The dampers will position, the control lockpin will engage, and the blade lockpin will disengage. The blade will fold, and the PRI SERVO PRESS light will go off.

WARNING

Ensure that the path of the blade is clear before tripping the manual override. Failure to do so could result in personal injury or damaged to the aircraft. The cyclic control stick may have to be moved slightly around neutral to engage the control lockpin.

Check the lights on the blade fold panel. CONT LOCKPIN ADV, BLADE FOLDED, CHECK BLADE FOLD, SAFETY VALVE OPEN, AND ACCESS DR ON lights should be lighted. The BLADE SPREAD light should be off. Trip the manual override button to SPREAD. The blade will spread and the lockpin will engage. The control lockpin will disengage. The BLADE SPREAD and CHECK BLADE FOLD lights will come on. Position the SAFETY VALVE switch to CLOSED. Check to see that the SAFETY VALVE OPEN and CHECK BLADE FOLD lights go off within 1 1/2 seconds and that the FLIGHT POS light comes on. Release the rotor brake to make sure that the ROTOR BRAKE ON light goes off. Manually reposition the No. 1 blade to the right of the helicopter centerline. Position the safety valve switch to OPEN and the master switch to ON. Make sure that SAFETY VALVE OPEN and FOLD PWR ON lights come on. Check to see that the ACCESSORY DR ON light is on. The rotor brake should disengage automatically. Hydraulic pressure should disengage the blade positioner drive unit from the rotor brake disc. The final movements of blade positioning may result in a position hunting motion or chatter. If this chatter is sustained for more than 3 seconds, investi-gate the cause. Position the blade fold switch to FOLD. The No. 1 BLADE POSITION light will come on. Apply the rotor brake manually. Damper-positioners will position, the control lockpin will engage, and the CONT LOCKPIN ADV light will illuminate. The blade lockpin will retract, and the BLADE SPREAD light will go off. The BLADE FOLDED and CHECK BLADE FOLD lights will come on.

NOTE: Automatic fold cycle time is approximately 30 seconds for the rotary-wing positioning. The normal time for damper positioning is 5 seconds, and normal time for blade folding is 27 to 41 seconds.

Make sure that the accumulator gauge on the No. 1 blade sleeve spindle maintains 3,000 psi. The damper-positioners should remain in full extended or autorotative position. The blades should remain folded. Position the blade fold switch to SPREAD, and check the reversing of operation. When the BLADE SPREAD light comes on, position the safety valve switch to CLOSED (SAFETY VALVE OPEN and FOLD PWR ON lights should then go out). Position MASTER and BLADE FOLD switches to OFF. CHECK BLADE FOLD light will go off, and FLIGHT POS light will come on. Visually check control lockpin for disengagement. Move the No. 1 blade to the left of the helicopter centerline. Repeat the automatic folding sequence. Following the hydraulic testing, inspect all components for external leakage. http://www.tpub.com/content/aviation/14018/