



BELL 212 Pilot Training Manual

CHAPTER 11
FLIGHT CONTROLS
CONTENTS

INTRODUCTION ----- 3

GENERAL-----3

COCKPIT FLIGHT CONTROLS----- 4

COLLECTIVE CONTROL SYSTEM-----4

 GENERAL-----4

 COLLECTIVE MAIN ROTOR CONTROLS -----5

 COLLECTIVE SLEEVE -----6

 ROTATING HUB -----6

 SCISSORS ASSEMBLY-----6

 STABILIZER BAR CONTROL TUBES-----6

 PITCH LINKS-----6

 COLLECTIVE CONTROL PITCH CHANGE MOVEMENT-----6

 COLLECTIVE FRICTION AND LOCK DOWN SYSTEMS-----8

 COLLECTIVE HEAD AND ENGINE THROTTLE FRICTION-----8

 TWISTGRIP THROTTLES-----9

CYCLIC CONTROL SYSTEM -----9

 GENERAL-----9

 CYCLIC STICK -----10

 MIXING UNIT -----10

 MIXING UNIT OPERATION -----10

 CYCLIC MAIN ROTOR CONTROL-----10

 CYCLIC CONTROL PITCH CHANGE MOVEMENT -----12

 CYCLIC FRICTION -----13

 CYCLIC FORCE TRIM-----13

ANTITORQUE CONTROL SYSTEM-----13

 GENERAL-----13

 ANTITORQUE CONTROLS-----13

FORCE TRIM SYSTEM -----14

 GENERAL-----14

 MAGNETIC BRAKE ASSEMBLIES-----16

 FORCE GRADIENT ASSEMBLIES-----16

 FORCE TRIM SYSTEM OPERATION-----16

SYNCHRONIZED ELEVATOR CONTROLS----- 17

GENERAL-----17

Campbell Helicopters



BELL 212 Pilot Training Manual

OPERATION	19
BELL IFR 212 CONTROLS	19
GENERAL DESCRIPTION	19
COLLECTIVE CONTROLS	19
CYCLIC CONTROLS	21
ANTI-TORQUE CONTROLS	23
SYNCHRONIZED ELEVATOR	23

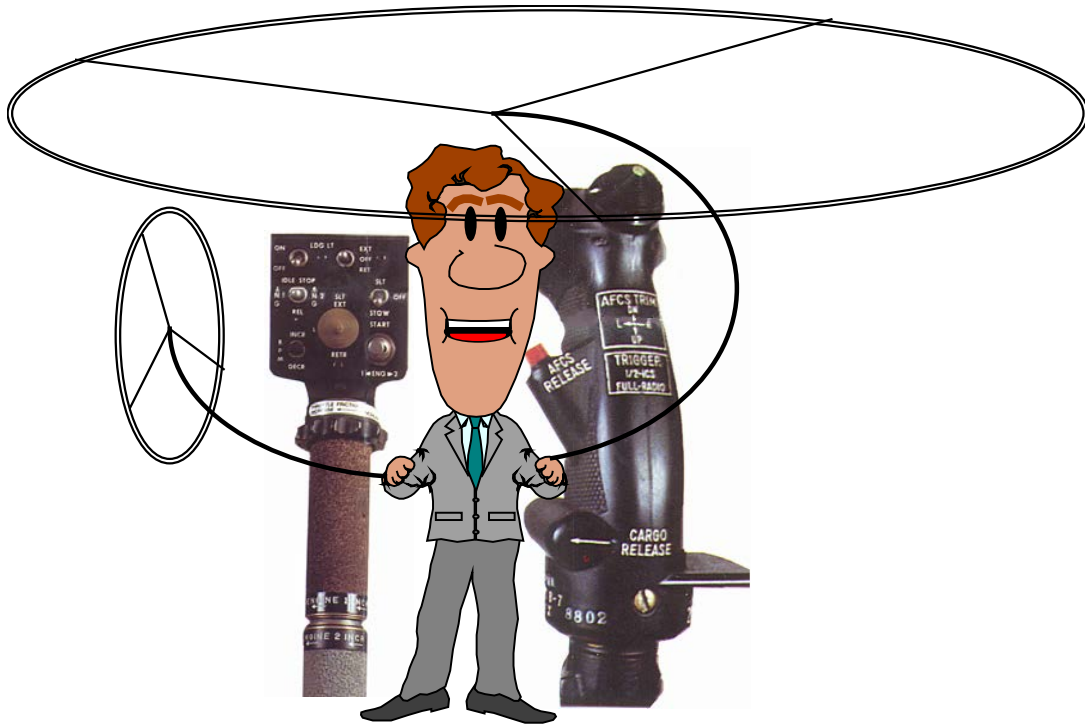
ILLUSTRATIONS

FIGURE 11-1	FLIGHT CONTROL SYSTEM	4
FIGURE 11-2	COLLECTIVE FLIGHT CONTROL SYSTEM	5
FIGURE 11-3	MAIN ROTOR CONTROLS (COLLECTIVE)	7
FIGURE 11-4	COLLECTIVE CONTROL PITCH-CHANGE MOVEMENT	7
FIGURE 11-5	FRICTION AND DOWN LOCK SYSTEM	8
FIGURE 11-6	COLLECTIVE HEAD - PILOT	8
FIGURE 11-7	CYCLIC CONTROL SYSTEM SCHEMATIC	9
FIGURE 11-8	MIXING UNIT	10
FIGURE 11-9	CYCLIC MIXING UNIT	11
FIGURE 11-10A	MAIN ROTOR CONTROLS (CYCLIC)	12
FIGURE 11-10B	CYCLIC CONTROL PITCH-CHANGE MOVEMENT	12
FIGURE 11-11	CYCLIC FRICTION	13
FIGURE 11-12A	TAIL ROTOR PEDALS ADJUSTMENT	14
FIGURE 11-12B	TAIL ROTOR PEDALS	14
FIGURE 11-13	ANTITORQUE FLIGHT CONTROL SYSTEM SCHEMATIC	15
FIGURE 11-14	MAGNETIC BREAK PILOT	16
FIGURE 11-15	FORCE TRIM SYSTEM	17
FIGURE 11-16	SYNCHRONIZED ELEVATOR	18
FIGURE 11-17	DROOP COMPENSATOR	20
FIGURE 11-18	FRICTION CLAMP	20
FIGURE 11-19	CONTROL COUPLING	20
FIGURE 11-20	THROTTLE LINKAGE	21
FIGURE 11-21	CYCLIC CONTROLS	21
FIGURE 11-22	CYCLIC FRICTION	22
FIGURE 11-23	SERIES ACTUATOR	22
FIGURE 11-24	PEDAL ADJUSTMENT	23
FIGURE 11-25	SYNCHRONIZED ELEVATOR	23



BELL 212 Pilot Training Manual

CHAPTER 11 FLIGHT CONTROLS



INTRODUCTION

Mechanical linkage systems, actuated by conventional helicopter controls, are used to control flight attitudes and direction. Systems include a cyclic control stick for fore, aft and lateral control, a collective pitch control and anti-torque pedals for directional control. A synchronized elevator is linked into the fore-aft control system to lengthen the CG travel and reduce the flat plate drag area.

GENERAL

All cockpit flight controls are hydraulically assisted to eliminate dynamic rotor feedback forces. A dual hydraulic boost system is installed to allow continued flight with one boost system inoperative.

Electrically operated force trims, connected to the cyclic and anti-torque controls, induce artificial control stick and pedals to prevent them from moving of their own accord. Positive stops are provided to prevent movement of the controls beyond safe limits.

The IFR version of the 212 requires the automatic flight control system, which provides increased stability and autopilot capability for reduced pilot workload. This is achieved by the integration of a stability and control augmentation system (SCAS) and attitude retention.

Cockpit flight controls, connected to push pull rods, bellcranks, SCAS actuators, and hydraulic servo actuators, transmit pilot movements directly to the rotor systems.

(Figure 11-1) illustrates the flight control systems.



BELL 212 Pilot Training Manual

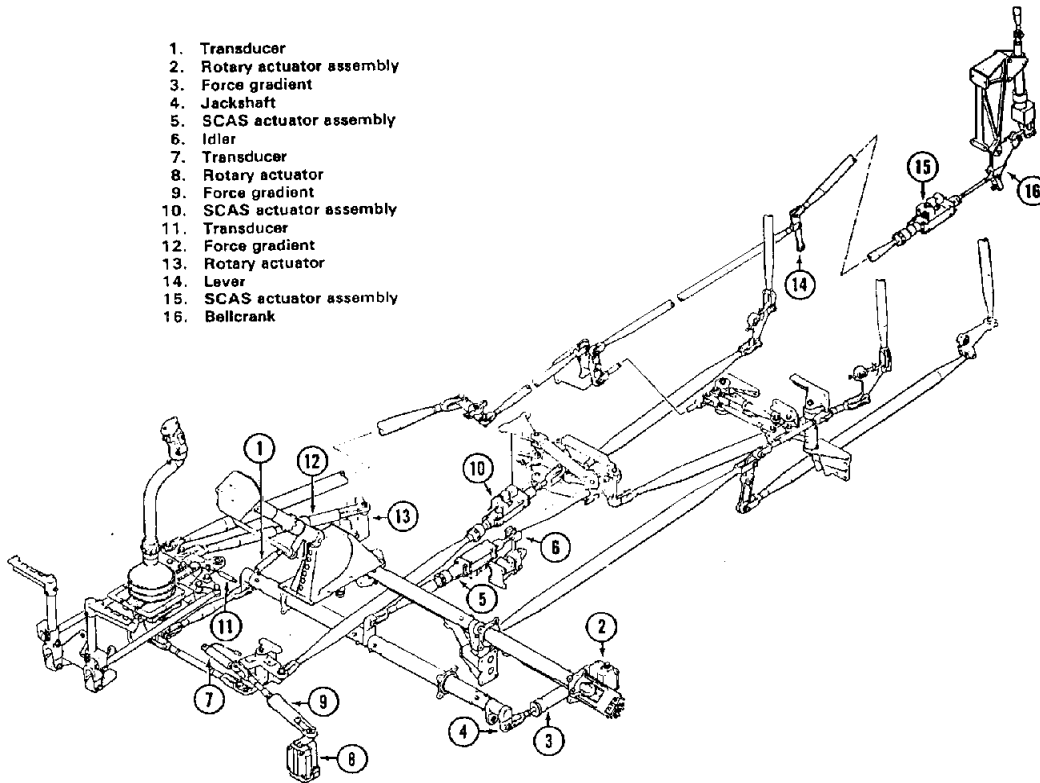


Figure 11-1 Flight Control System

COCKPIT FLIGHT CONTROLS

The cockpit flight controls include the collective, the cyclic stick, and the antitorque pedals and their associated friction, down locks, and force trim systems.

COLLECTIVE CONTROL SYSTEM

General

The collective pitch control system (Figure 11-2), consists of a jackshaft assembly with the pilot's control stick, push-pull tubes and bellcranks and a dual hydraulic cylinder

connected to a control lever below the swashplate.

The pilot's collective pitch control stick extends up and forward through flexible boots in the floor at the left side of the pilot's seat and is connected to a jackshaft mounted laterally under the cabin floor. On the left end of the jackshaft, below the co-pilot's seat, is a minimum friction device to prevent "Collective bounce." A knurled collar in the pilot's stick allows adjustment, by the pilot, of friction drag on the collective stick. A spring-loaded down lock is provided on the floor, below the pilot's stick, to secure the collective in a full down position. Twist-grip type power controls, upper engine No.1 lower engine No.2, with individual friction adjustments are incorporated on the collective control stick.



BELL 212 Pilot Training Manual

1. PILOT COLLECTIVE
2. BOOT
3. JACKSHAFT
4. CONTROL ARM
5. CONTROL TUBE
6. LEVER
7. BELLCRANK
8. SUPPORT
9. COLLECTIVE SERVO
10. COLLECTIVE LEVER
11. SPRING
12. ACTUATOR ARM

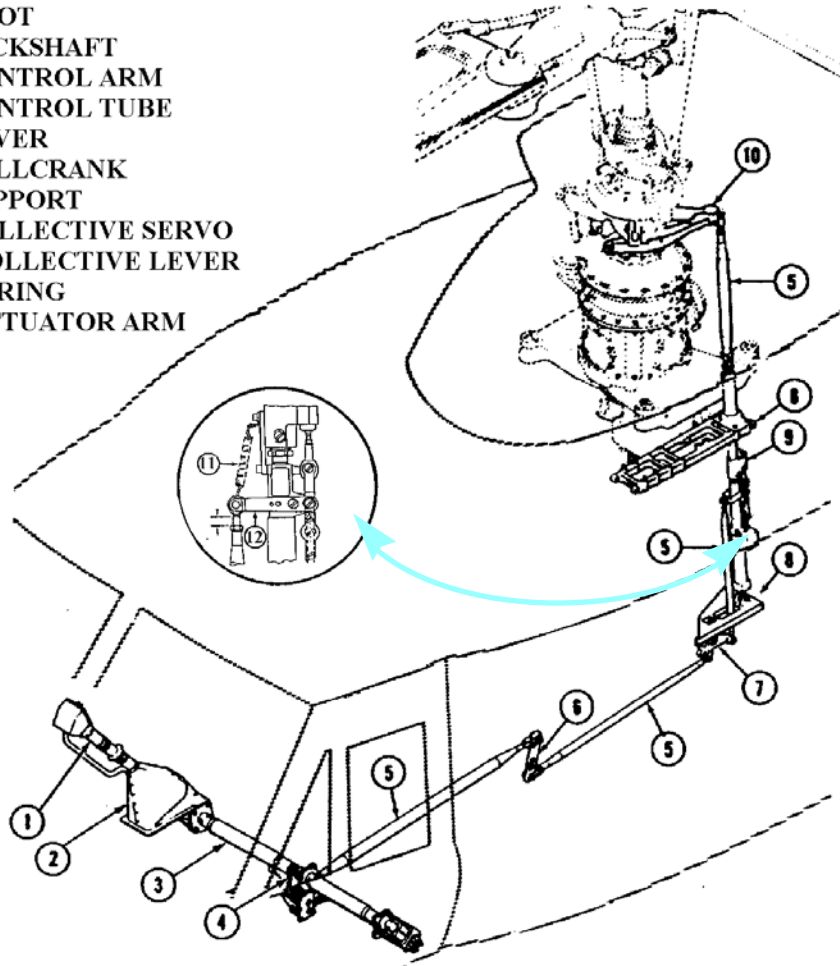


Figure 11-2 Collective Flight Control System

A switch box mounted on top of the pilot's collective stick contains control switches for engine starters, engine governor N2 RPM control, flight idle stop releases, landing light and search light control.

Movement of the collective control stick is transmitted through linkage and dual power cylinder to the main rotor pitch control mechanism, causing the helicopter to ascend or descend or to remain at a constant altitude. The hydraulic power cylinder incorporates a check valve system to afford irreversibility to reduce feedback forces to

the controls in the event of hydraulic power failure. Additional linkage attached before the servo No.7, (Figure 11-2) transmits collective movement through a droop cam compensating unit to the N2 governors.

Collective Main Rotor Controls

All collective pitch change of the main rotor blades results from movement of the collective sleeve (Figure 11-3). The collective sleeve, in turn, moves the rotating hub assembly, the scissors assembly, the

Campbell Helicopters



BELL 212 Pilot Training Manual

stabilizer bar control tubes, the pitch links, and the blade grips to the rotor blades.

Collective Sleeve

The collective sleeve is a tube surrounding the lower portion of the rotor mast. Movement of the collective lever moves the sleeve up and down around the rotor mast.

Rotating Hub

The top of the collective sleeve is attached by bearings to a hub which is splined to and driven by the main rotor mast. The hub rotates with the rotor mast and is free to move up and down on the mast splines when moved by the collective sleeve.

Scissors Assembly

The rotating aluminum scissors assembly is attached to and driven by the rotating hub. They transmit the vertical movement to the rotor disc via the two stabilizer bar control tubes that are mounted to the long arms of the scissors assembly and move the tubes up or down simultaneously and in the same direction for collective movement.

Stabilizer Bar Control Tubes

From the long arm end of the scissors assembly the stabilizer bar control tubes mount to the outer arm of the stabilizer bar mixing lever. The movement of the control tubes moves the mixing levers up or down simultaneously and in the same direction.

Pitch Links

The pitch links are installed between the inboard part of the mixing lever arms and the outer arm of the pitch horn. Movement of the mixing levers moves the pitch links up and down, which pushes the pitch horns,

rotates the blade grips, and results in main rotor blade pitch change equally, simultaneously, and in the same direction.

Collective Control Pitch Change Movement

Following is a list of movements for each part of the collective flight control linkage that occur when the collective flight control is pulled up. Figure 11-4 shows each movement as identified by the corresponding number below:

1. Collective control linkage moves the collective servo up.
2. Collective servo pushes the collective lever up.
3. Collective lever pivots and moves collective sleeve up.
4. Collective sleeve moves the rotating hub up.
5. Hub moves arms of scissors assembly up.
6. Scissors assembly pushes the stabilizer bar control tubes up.
7. Stabilizer bar control tubes push the outboard end of the stabilizer bar mixing levers up.
8. Stabilizer bar mixing levers pull the pitch links up.
9. Pitch links pull each rotor blade pitch horn up.
10. Pitch horns increase pitch angle on each blade grip and rotor blade.

Moving the collective control down results in exactly the same flight control movements as described in the steps above but in the opposite direction.



BELL 212 Pilot Training Manual

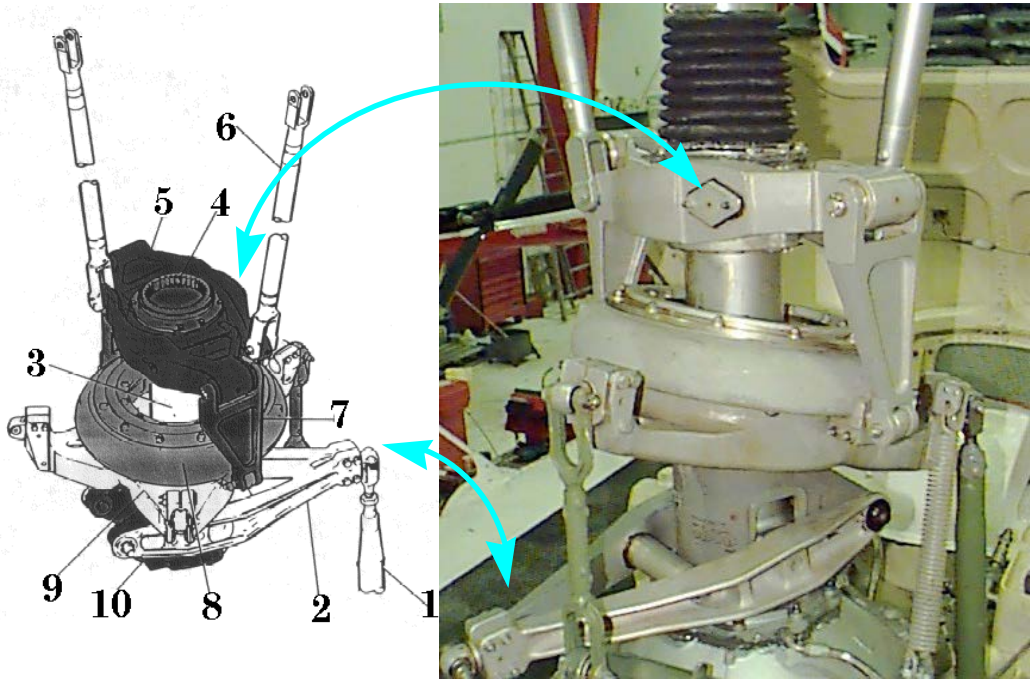


Figure 11-3 Main Rotor Controls (Collective)

- | | |
|---------------------------|--------------------------------|
| 1. Collective Control Rod | 6. Stabilizer Bar Control Tube |
| 2. Collective Lever | 7. Drive Link |
| 3. Collective Sleeve | 8. Rotating Swashplate |
| 4. Rotating Hub | 9. Non-rotating Swashplate |
| 5. Scissors Assembly | 10. Support Assembly |

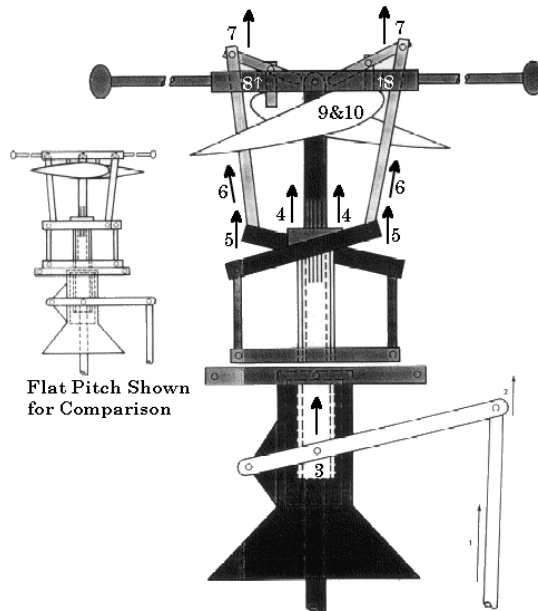


Figure 11-4 Collective Control Pitch-Change Movement (Up Collective Movement Shown)



BELL 212 Pilot Training Manual

Collective Friction and Lock Down Systems

Adjustable collective friction (Figure 11-5), located below the engine twist grips on the pilot's collective flight control, can be increased or decreased to provide the amount of desired stiffness for both collective controls. The collective flight control linkage has 8 to 10 pounds, with hydraulic systems on, of built-in collective friction.

The collective control down lock (Figure 11-5), located between the pilot's collective control and the seat, may be used to hold the collective control in the fully down position.

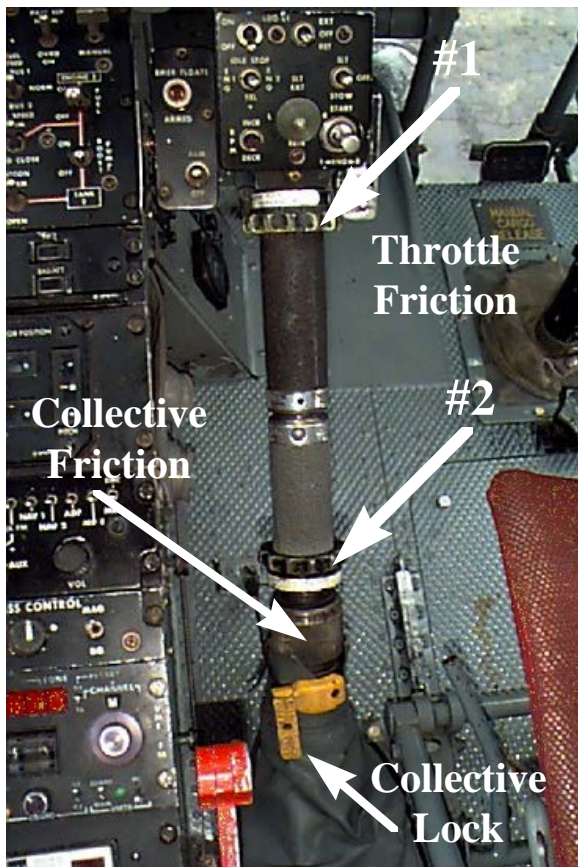


Figure 11-5 Friction and Down Lock System

The collective flight control system does not incorporate force trim.

Collective Head and Engine Throttle Friction

The cockpit collective control, in addition to controlling the vertical flight of the helicopter, also mounts the collective head and the twistgrip throttles for each engine (Figure 11-6).



Figure 11-6 Collective Head - Pilot

The collective head contains numerous system switches which are listed below with a reference for a more detailed discussion of their function:

LDG LT switches are discussed in the Chapter on "Lighting."

FLOATS switch is discussed in the Chapter "kits and Accessories."

IDLE STOP switches are discussed in Chapter on "Powerplant."



BELL 212 Pilot Training Manual

START switches are discussed in Chapter on "Powerplant."

SRCH LT switches are discussed in Chapter on "Lighting."

RPM switch is discussed in Chapter 7D on "Powerplant."

Twistgrip Throttles

The twistgrip throttles, discussed in Chapter on "Powerplant," are sleeved around the cockpit collective control and include separate friction adjustments to allow setting the desired throttle stiffness. (Figure 11-5)

CYCLIC CONTROL SYSTEM

General

The cyclic control changes individual rotor blade pitch and lift to tilt the rotor tip-path plane and resultant rotor lift vector in the desired direction of flight (Figure 11-7). The cyclic control system consists of pilot's cyclic control stick, push-pull tubes, bellcranks, mixing levers, two dual hydraulic power cylinders and electrically operated force trim units.

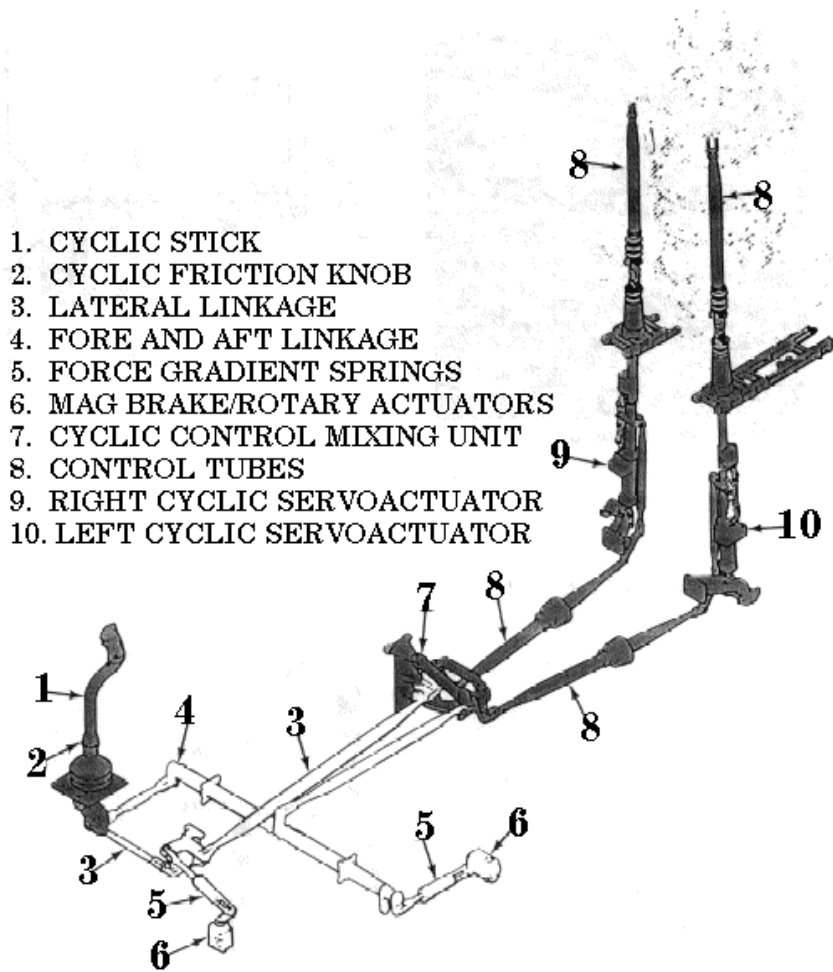


Figure 11-7 Cyclic Control System Schematic

Campbell Helicopters



BELL 212 Pilot Training Manual

Cyclic Stick

The cyclic stick is mounted through the floor in front of the pilot's seat. The stick has an adjustable friction device and is equipped with a trigger type intercom and communications switch, cargo hook release switch and force trim switch. If installed, the co-pilot's cyclic is identical to the pilot's with the exception of the friction device.

The cyclic control stick provides the pilot with lateral and longitudinal control of the main rotor. Movement of the cyclic control stick is transmitted through the linkage and hydraulic cylinders to the swashplate. Two dual hydraulic power cylinders are incorporated to reduce effort required for control and to reduce feedback. Force gradient units, with magnetic brakes, are incorporated for artificial control feel and stabilization of controls.

Mixing Unit

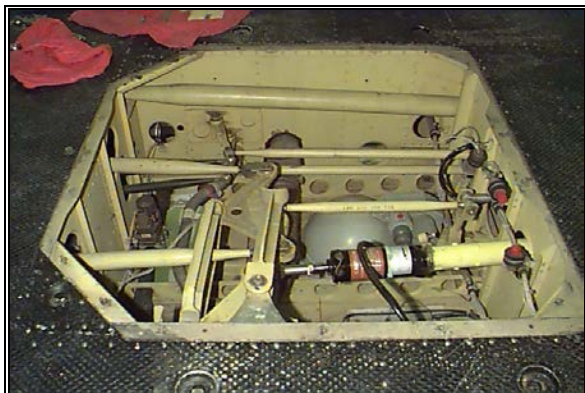


Figure 11-8 Mixing Unit

The mixing unit (Figure 11-8) converts lateral and fore and aft cyclic control inputs into movements that are compatible for use by the two cyclic servos and the swashplate of the main rotor controls. The mixing unit includes a fore and aft bellcrank, a lateral bellcrank, paralleling levers between the fore and aft bellcrank, and control rods to the two cyclic servo actuators.

Mixing Unit Operation

Fore and aft cockpit cyclic control movement causes the fore and aft control rod to move the fore and aft bellcrank straight forward or backward. The fore and aft bellcrank moves the control rods connected to the cyclic servos an equal amount in the same direction, either forward or backward. The cyclic servos convert this action to equal up or down movement of the gimbal mounted non-rotating swashplate, which results in the swashplate being tilted forward or backward.

Lateral cockpit cyclic control movement causes the lateral control rod to rotate the lateral bellcrank, which moves the lower connecting lever attached to the fore and aft bellcrank.

The lower connecting lever rotates the fore and aft bellcrank and moves the push pull tubes connected to the cyclic servos an equal amount but in opposite directions. The servos convert this action into one servo moving up and the other servo moving down an equal amount, which results in the non-rotating swashplate being tilted right or left.

Since cockpit cyclic movement is normally never only lateral or fore and aft but rather a combination of the two, the cyclic mixing unit is ideally designed to mix the two cyclic control inputs to achieve the necessary tilt of the swashplate. Tilting the swashplate activates the main rotor controls to effect necessary individual blade pitch changes which result in tilting the main rotor tip path plane.

Cyclic Main Rotor Control

A second swashplate, bearing mounted to the non-rotating swashplate, is free to rotate in a plane parallel to the non-rotating swashplate (Figure 11-9). Cockpit cyclic control movements which tilt the gimbal mounted non-rotating swashplate also tilt

Campbell Helicopters

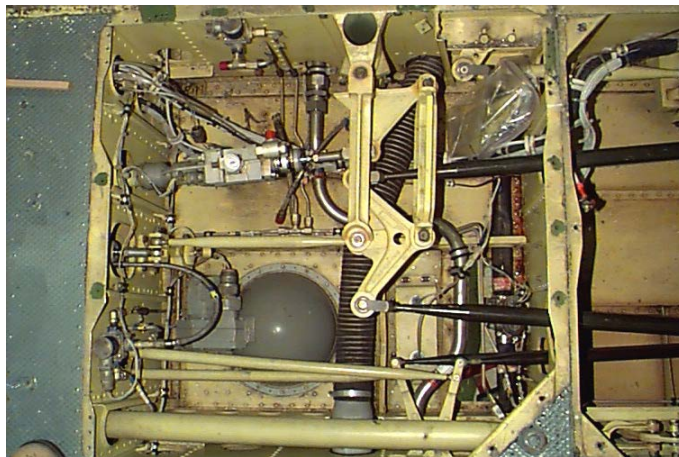


BELL 212 Pilot Training Manual

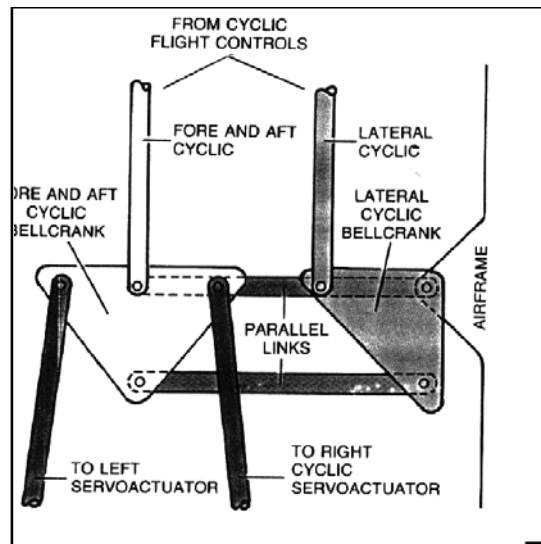
the rotating swashplate, which converts non-rotating control inputs into rotating control inputs.

the non-rotating swashplate to the scissors assembly.

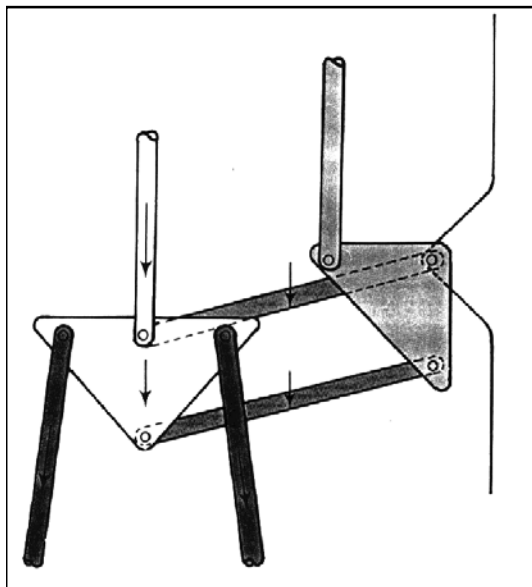
The two swashplate drive links, mounted to the rotating swashplate, transfer the tilt of



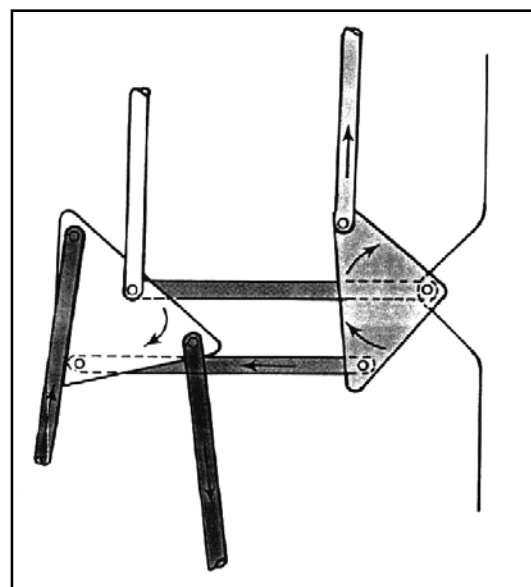
Cyclic Mixing Unit



Neutral Cyclic



Aft Cyclic



Left Cyclic

Figure 11-9 Cyclic Mixing Unit



BELL 212 Pilot Training Manual

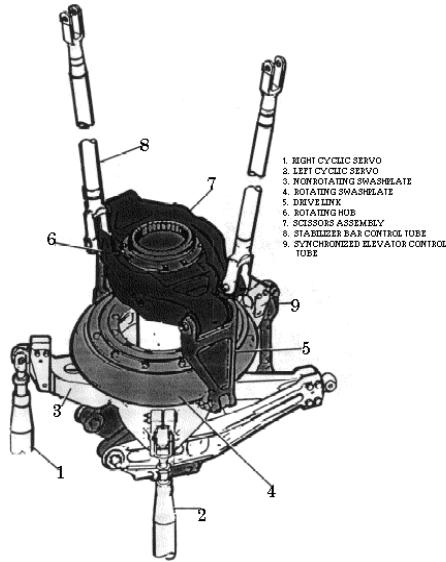


Figure 11-10a Main Rotor Controls (Cyclic)

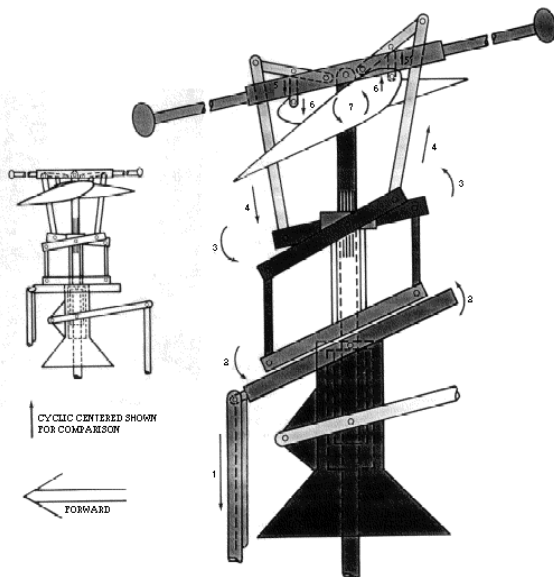


Figure 11-10b Cyclic Control Pitch-Change Movement

(Forward Cyclic Movement Shown)

The two scissor levers, attached to the rotating hub, pivot inboard on the rotating hub and outboard on the drive links and

convert, through the stabilizer bar control tubes and pitch links, the tilt of the rotating swashplate to different pitch angles on each main rotor blade.

Cyclic Control Pitch Change Movement

Following is a list of movements for each part of the cyclic flight control linkage that occur when the cyclic flight control is moved forward.

(Figure 11-10b) shows each movement as identified by the corresponding number listed below:

1. Cyclic servos tilt the non-rotating swashplate forward.
2. Non-rotating swashplate tilts the rotating swashplate forward.
3. Rotating swashplate tilts the scissor levers as they rotate.
4. Scissor levers move stabilizer bar control tubes up/down as they rotate.
5. Stabilizer bar control tubes move the pitch links up/down as they rotate.
6. Pitch links move the blade pitch horns up/down.
7. Pitch horns rotate the blade grips and change rotor blade pitch angle up/down.

Each blade flies according to the lift it produces and gyroscopic precession. With the swashplate tilted forward, the blades fly down in front and up in the rear with the tip path plane tilted forward. Relative to cyclic, the tip path plane is parallel to the swashplate.

Moving the cyclic control aft results in exactly the same flight control movements as above except in the opposite direction.

Campbell Helicopters



BELL 212 Pilot Training Manual

Likewise, lateral cyclic movement results in tilting the rotor right or left. Any time the cyclic flight control is moved, an equal and simultaneous but opposite direction change of opposing blade pitch angle occurs.

Cyclic Friction

The pilot's cockpit cyclic control includes both built in and adjustable friction to stiffen cyclic cockpit control movement (Figure 11-11).



Figure 11-11 Cyclic Friction

An adjustable nut, below the built in friction clamp on the pilot's cyclic stick, allows the pilot to increase cyclic stiffness as desired.

Cyclic Force Trim

The Cyclic force trim system provides "stick positioning and artificial "feel" for the cockpit cyclic flight control.

ANTITORQUE CONTROL SYSTEM

General

Left rotation of the main rotor, as viewed from above, creates a right torque or turning moment around the main rotor mast. This tends to turn the helicopter nose to the right. The main rotor torque increases as

collective pitch increases and decreases when collective pitch decreases. A tractor tail rotor is mounted on the right side of the tailboom and pulls the tailboom right, which moves the helicopter's nose left to counteract main rotor torque. This mounting system is called a Tractor Tail Rotor. It provides more thrust in the hover and more power in cruise flight

The tail rotor or anti-torque control system collectively changes the pitch angle of the tail rotor blades to increase or decrease the total amount of tail rotor thrust required to counteract main rotor torque. The amount of tail rotor collective pitch change is controlled by the cockpit tail rotor pedals and provides heading control in hovering flight and coordination during cruise flight.

Antitorque Controls

The antitorque pedals are hinged below floor level in front of each pilot's seat and connect to a pedal adjustment assembly. The pilot's and co-pilot's pedal adjustment assemblies are interconnected, and each includes an adjustment knob that allows the pedal to seat distance to be increased or decreased. The spring loaded up adjustment knob functions only when it is pushed down and then turned (Figure 11-12a).

The forward bellcrank incorporates a friction clamp which provides approximately 4.5 pounds of built-in friction. The pilots pedal adjustment assembly bellcrank is also connected to the antitorque force trim system.

Tail rotor force trim provides pedal positioning and artificial "feel." The force gradients for the tailrotor force trim are identical in operation to the cyclic force trim functions, and it is activated through the same switches as the cyclic force trim system. For additional information on the tail rotor pitch change mechanism, see Chapter on "Tail Rotor."



BELL 212 Pilot Training Manual

FORCE TRIM SYSTEM

General

Hydraulically powered flight controls do not have any aerodynamic force "feel" nor are the flight controls trimmed by dynamic forces for hands off flight. An electromechanical force trim system is included in the flight control system to provide these features.

Force trim consists of magnetic brake assemblies, to provide flight control positioning, and force gradient spring assemblies installed between the flight control linkage and the magnetic brakes, to allow movement of the cyclic and pedals when the magnet brake assemblies are locked. Without the force gradient springs the pilot would NOT be able to move the flight controls with the Force Trim engaged. Movement of the force gradient springs (compression - extension) produces the artificial control "feel." Separate force trim is provided for lateral cyclic, fore and aft cyclic, and the antitorque pedals. The collective does not have force trim (Figure 11-11).

Magnetic brake assemblies are electrically powered by 28 VDC electrical power, protected with a FORCE TRIM circuit breaker, and controlled by a guarded FORCE TRIM switch on the MISC panel on the center pedestal and force trim release switches located on each pilot's cyclic grip. With the force trim switched on, the force trim system is activated. Depressing either of the force trim release button switches on the cyclic grips breaks the electrical circuit and deactivates the force trim system. The system remains deactivated as long as either force trim release switch is held down.

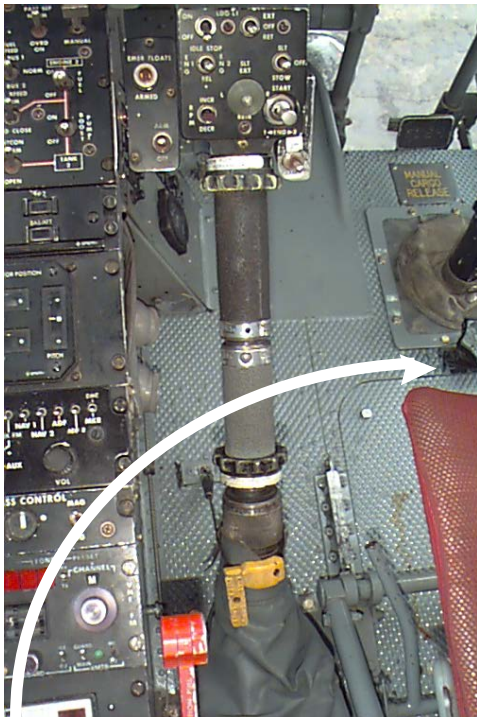


Figure 11-12a Tail Rotor Pedals Adjustment

The pilot's pedal adjustment assembly is connected to a series of control rods and bellcranks which connect to the single-acting hydraulic anti-torque servo actuator located in the heater compartment. Additional control tubes and bellcranks



Figure 11-12b Tail Rotor Pedals

transmit servo actuator movement to the tail rotor pitch change mechanism on the tail rotor gearbox (Figure 11-13).



BELL 212 Pilot Training Manual

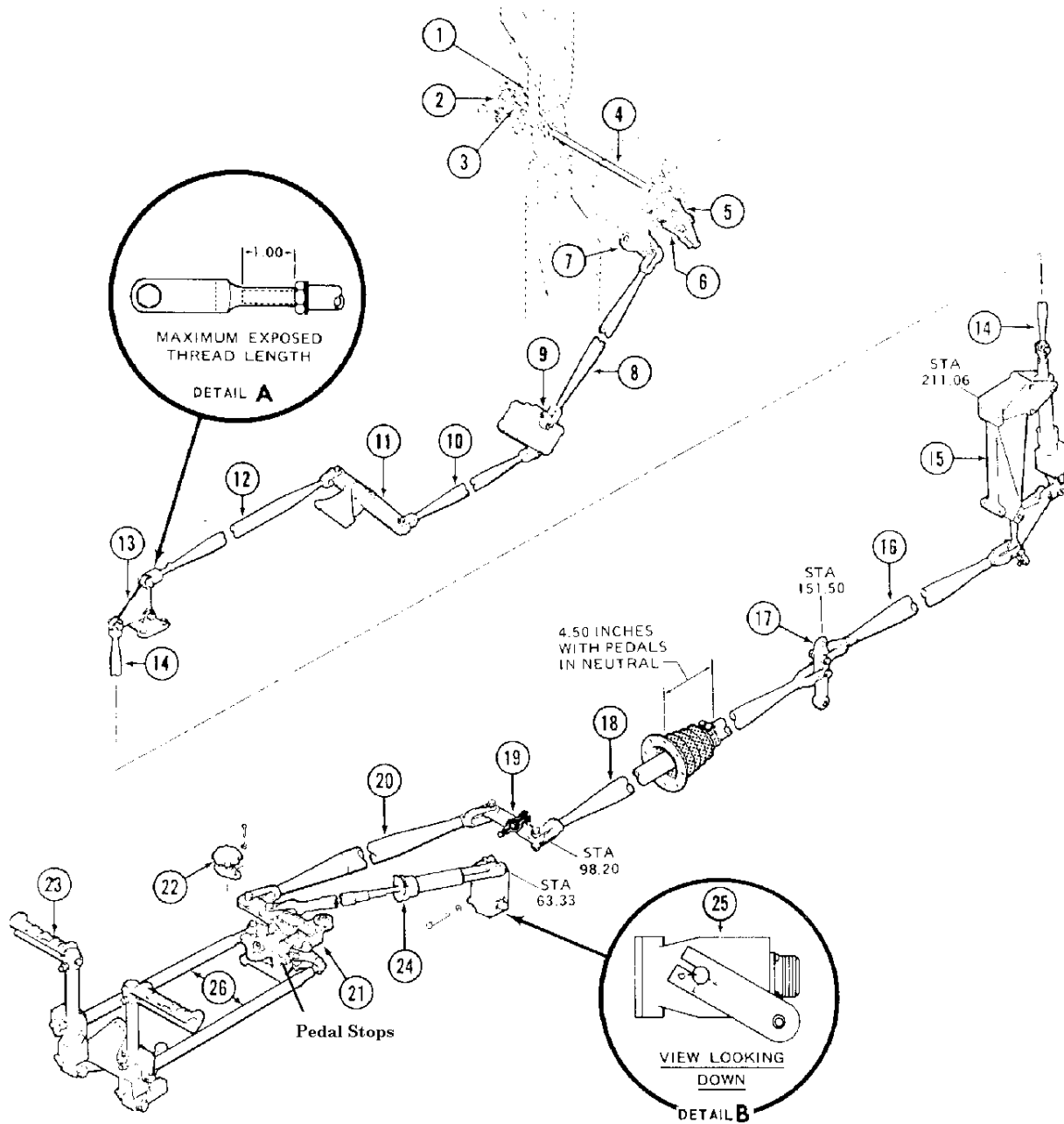


Figure 11-13 Antitorque Flight Control System Schematic



BELL 212 Pilot Training Manual

Magnetic Brake Assemblies



Figure 11-14 Magnetic Brake Pilot

The three airframe mounted magnetic brake assemblies, one for lateral cyclic, one for fore and aft cyclic, and one for anti-torque, connect through force gradient assemblies to the associated flight control linkage. Each magnetic brake includes an electromagnet which acts on a disc attached to a control arm. The control arm is connected to one end of a force gradient assembly. The other end of the force gradient assembly is connected to the flight control linkage. With the force trim system on, electrical power energizes the electromagnets which hold the discs and control arms in a fixed position to provide flight control positioning.

Force Gradient Assemblies

Force gradient spring assemblies, attached between the magnetic brake control arms and the flight controls, incorporate two way acting springs which allow movement of the flight controls, and provide "feel" to the flight control any time the control is moved from the position maintained by the magnetic brakes. The lateral force gradient assembly requires approximately 3 pounds of force to move it against the spring. Fore and aft requires approximately 6 pounds of force, and the pedals require approximately 3 pounds.

Force Trim System Operation

Force trim is switched on by moving the red guarded FORCE TRIM switch to ON. This is most conveniently accomplished by ensuring that the red cover is down. With the red cover down, the switch can only be in the ON position.

In flight, with force trim on, the force gradient assemblies induce "feel" any time the cyclic or pedals are moved from the position in which they are being magnetically held. If the pilot is constantly holding pressure on the flight controls, against the force gradient springs, the force trim release switch may be used to re-trim the flight controls to a new magnetically held position.

A force trim release switch on each pilot's cyclic grip allows the force trim system to be temporarily interrupted. Depressing the switch interrupts electrical power to the magnetic brakes, and the force gradient springs re-center themselves. Releasing the force trim release switch re-energizes the magnetic brakes and holds the flight controls in a new position.

If the pilot is holding control pressure when a force trim release switch is depressed, the helicopter may yaw, pitch, or roll slightly due to the sudden release of pressure. It is recommended that the force trim release switch be depressed prior to making control movements and then released after the control movement is complete.

The pilot should check for proper force trim system operation during the Force Trim Check in the Systems Checks portion of Section 2, "Normal Procedures," of the RFM. It is possible that the Force Gradient may be "freed up" in one direction and not another, preventing movement of the cyclic in that direction unless the release is pressed.



BELL 212 Pilot Training Manual

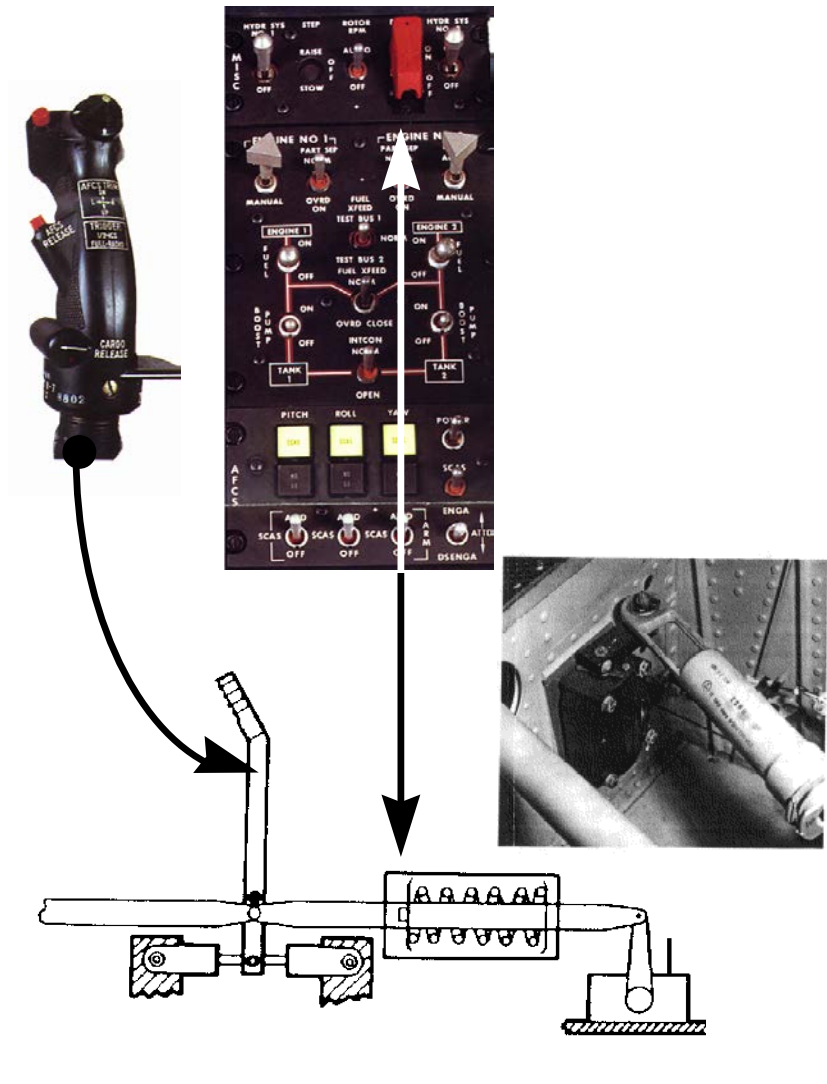


Figure 11-15 Force Trim System

**SYNCHRONIZED
ELEVATOR CONTROLS**

GENERAL

All helicopters incorporate some form of horizontal elevator to improve longitudinal stability in the pitch axis. Some elevators are fixed; others, such as used on the Bell 212, are movable through interconnection with the flight control system.

The synchronized elevator, mounted near the rear of the tailboom, provides longitudinal stability and produces downward lift to keep the helicopter nose up as forward airspeed increases. By leveling the helicopter during high speed forward flight, a longer center of gravity range can be maintained.

The elevator system includes two inverted airfoil shapes, one on each side of the

Campbell Helicopters



BELL 212 Pilot Training Manual

tailboom, mounted on a spar tube within a center elevator horn (Figure 11-15).

The two halves of the elevator are attached to the center spar at different angles of incidence to compensate for the dissimilar air flows produced by main rotor downwash.

The right half of the elevator has a slightly more nose up angle than the left half. If not corrected for in this manner, rotor downwash on the elevator causes a rolling moment in the helicopter.

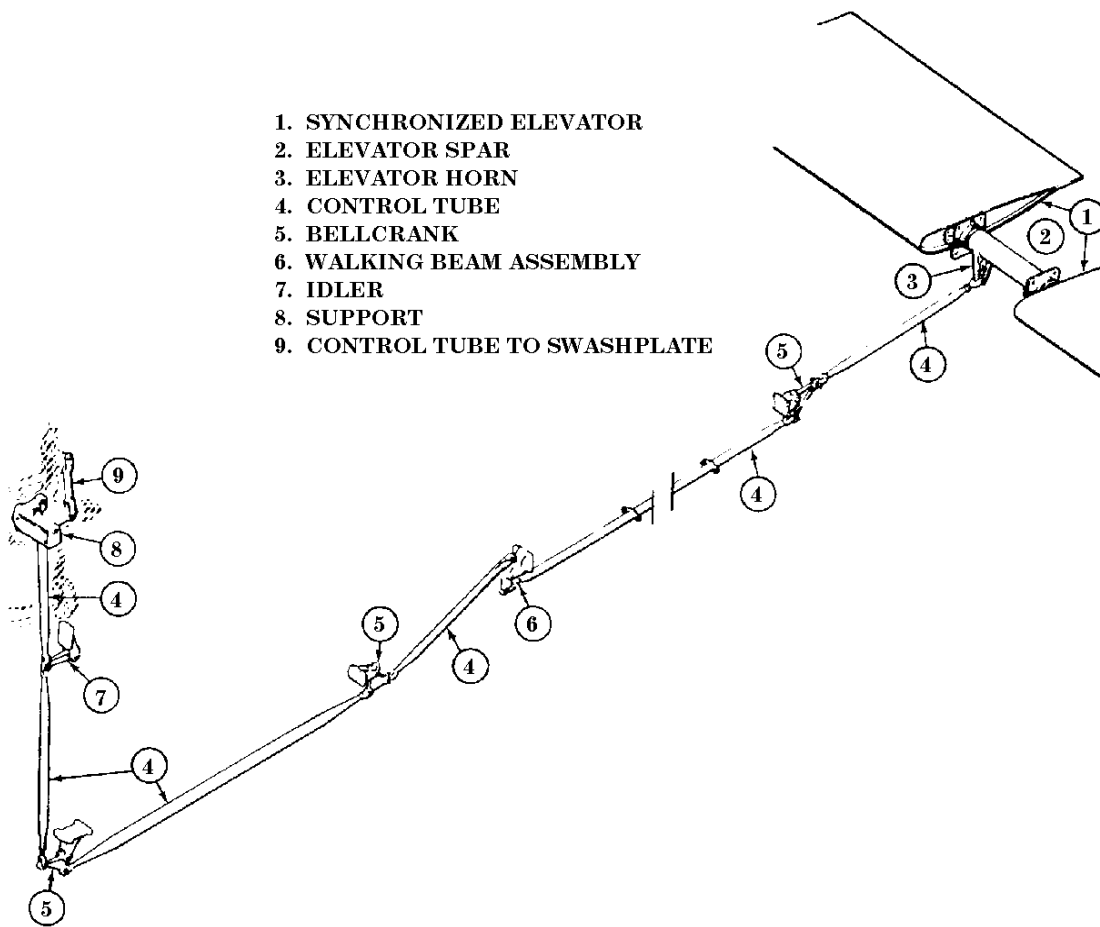
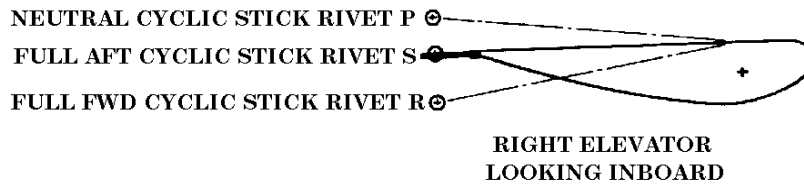


Figure 11-16 Synchronized Elevator

Campbell Helicopters



BELL 212 Pilot Training Manual

The elevator spar and horn are bearing-mounted through the tailboom and are attached to a series of push pull tubes and bellcranks to the rear of the non-rotating swashplate.

OPERATION

(Bell IFR 212 Only)

With the helicopter in hover flight, the elevator is held in its full nose down position by the swashplate, push pull tubes, and bellcranks. As forward flight is initiated, the nose tends to pitch down due to the tilt of the main rotor disk. As forward airspeed increases, the elevator produces downward lift, creating a downward force on the tailboom to prevent pitch down of the nose. With the increase of airspeed the elevator would build up enough down force to cause the nose to pitch up more than desired due to the increased angle of attack on the synchronized elevator and resultant increased downward lift. To compensate for this, when forward flight is initiated by the cyclic control being moved forward, the swashplate tilts forward, pulls the synchronized elevator control tube up, and through a series of push pull tubes and bellcranks pulls the horn on the elevator spar, rotating the synchronized elevators nose up. This decreases the angle of attack on the synchronized elevator, unloading some of the downward lift, and results in the desired longitudinal control.

Cyclic movement aft results in the synchronized elevators rotating to a more nose down position. The synchronization of the elevators to the swashplate, and thus cyclic, position, results in keeping the helicopter relatively level in flight.

The synchronized elevator movement in the VFR 212 and Sperry 212 is different in that the trailing edge of the elevator is full up with the cyclic in neutral, full down with the cyclic full Forward, and level with the cyclic full AFT. The purpose of the synchronized

elevator remains, to keep the helicopter relatively level in forward flight.

BELL IFR 212 Controls

General Description

The mechanical linkage systems, actuated by conventional helicopter controls, are used to control flight attitude and direction. Systems include a cyclic control stick for fore-aft and lateral control, a collective pitch control stick for vertical control, and tail rotor control pedals for directional control. A synchronized elevator is linked into the fore-aft control system.

On a typical helicopter in flight, a change in collective pitch requires a pilot control input into the longitudinal cyclic and directional controls to maintain the previous trimmed condition. A mechanical interconnect control coupling system is added to the basic flight control system, to automatically introduce corrective compensation into the controls whenever there is collective pitch change. A droop compensation system for the N2 engine governors is mechanically linked to the collective control system also.

Collective Controls

General

A system of linkage transmits movement of the collective sticks to collective levers which actuate the main rotor pitch control mechanism, causing the helicopter to ascend, descend or remain at a constant altitude. A dual servo actuator provides a hydraulic boost to the controls and prevents rotor forces from being transmitted to the controls. Collective system movement, through mechanical linkage, actuates a coupling crank/lever installation to introduce control movement into the anti-torque controls.

Campbell Helicopters



BELL 212 Pilot Training Manual

The engine droop compensator (N2) controls are connected to and actuated by the collective control system.

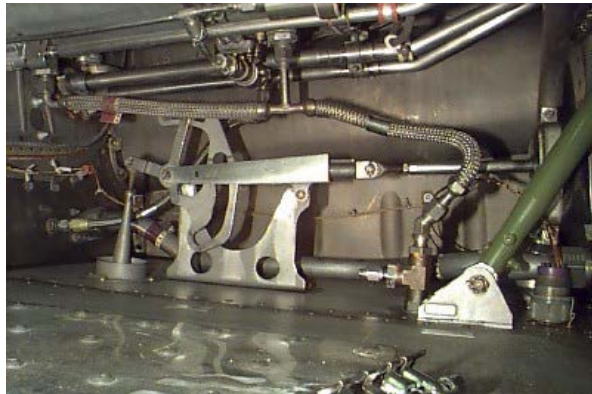


Figure 11-17 Droop Compensator

An adjustable friction clamp, located under the floor by the co-pilot's seat, (Figure 11-18) allows for setting of minimum collective bounce. The minimum friction (as measured between No.1 and No.2 twist grips) is set 13 to 14 pounds with hydraulic boost OFF, and control tube disconnected or 8 to 10 pounds with hydraulic boost ON and system connected. The collective system primary stops are located at the base of the pilot's collective stick. The collective controls are adjusted so as to provide a low blade angle of $8\pm 1/2$ degrees positive pitch.

Collective Stick

The pilot's collective pitch control stick extends up and forward through flexible boots in the floor at the left side of the pilot's seat and is connected to a jackshaft mounted laterally under the cabin floor. A knurled collar on the pilot's stick allows adjustment, by the pilot, of friction drag on the collective stick. A spring-loaded down lock is provided on the floor, below the pilot's stick, to secure the collective in a full down position.

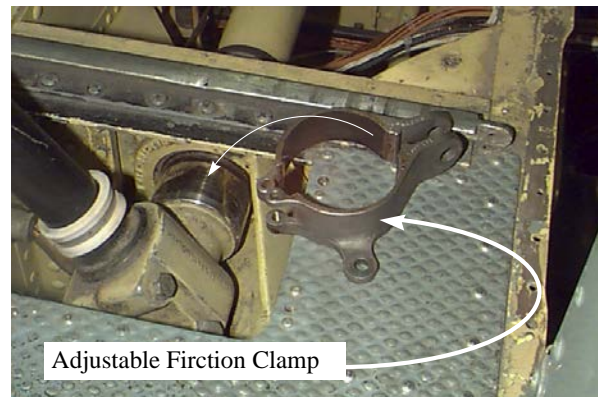


Figure 11-18 Friction Clamp

Twist-grip type power controls, upper engine No.1 and lower engine No.2, with individual friction adjustments are incorporated on the collective control stick. A switch box mounted on top of the pilot's collective stick contains control switches for engine starters, engine governor N2 RPM control, flight idle stop releases, and search light control.

Flight Control Coupling

To reduce pilot work load during climbs, descents and airspeed changes, a flight control coupling system puts corrective compensation into the tail rotor controls whenever the collective lever is moved.

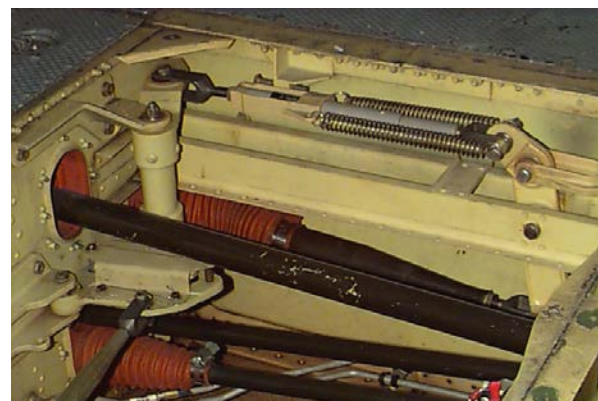


Figure 11-19 Control Coupling

The amount of corrective input varies with the amount of collective pitch change, the

Campbell Helicopters



BELL 212 Pilot Training Manual

airspeed, gross weight and the center of gravity. The mechanical linkage of the flight control coupling system is comprised of push-pull tubes, bellcranks, and torque tube.

The flight control coupling system is connected to the collective system at a bellcrank under the cabin floor. Collective control movements will be transmitted through levers to the torque tube. The torque tube transmits corrective movements to the directional controls through the scissors assemblies. The scissors assembly allows corrective input into the controls without the inputs being felt in the cockpit.



Figure 11-20 Throttle Linkage

Cyclic Controls

The cyclic control stick provides the pilot with lateral and longitudinal control of the main rotor. Movement of the cyclic control stick is transmitted through the linkage and hydraulic cylinders to the swashplate. Longitudinal and lateral control movements are independent separate movements from the cyclic stick. The mixing bellcrank assembly takes a single control input from the lateral or longitudinal control output. The lateral and longitudinal control movements are also combined together at the mixing bellcrank so as to provide a dual movement to the swashplate. Two dual hydraulic power cylinders are incorporated to reduce effort required for control and prevent feedback forces from the main rotor.



Figure 11-21 Cyclic Controls

Campbell Helicopters



BELL 212 Pilot Training Manual

Each cyclic stick grip incorporates the following switches:

- ◆ ATTD TRIM - FWD, AFT, L, R & CENTER
- ◆ CARGO REL - Push button
- ◆ MOMENTARY FORCE TRIM OR AFCS DISCONNECT - Push button
- ◆ TRIGGER - 1/2 ICS - FULL RADIO
- ◆ AFCS and SCAS RELEASE - Push button

Pilot's cyclic stick incorporates a stick friction adjustment with minimum friction stop clamp. With minimum friction applied at the cyclic stick, all series actuator movements will be transmitted back to the rotor instead of through the cyclic stick. The minimum friction clamp is set at 1-1/2



Figure 11-22 Cyclic Friction

pounds (as measured from the center of the cyclic grip). Cyclic system primary stops are located in support assembly of each stick. Two series actuators, pitch and roll, are connected on series with their

mechanical linkage prior to the mixing bellcrank.

The series actuators transmit mechanical control movements upon commands from the stability and control augmentation system (SCAS). The mechanical control movement of the series actuator is made by

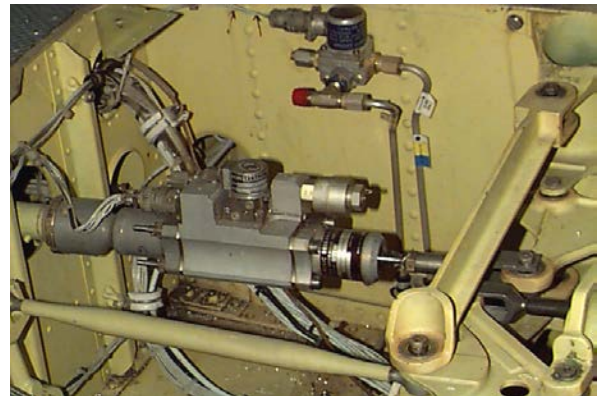


Figure 11-23 Series Actuator

expanding or contracting the rod in the actuator. The control movement is prevented from feeding back to the cyclic stick by applying a minimum friction to the cyclic stick. The control movement, seeking the path of least resistance will then transmit itself back to the rotor. SCAS stops are located after the series actuators. The SCAS stops prevent the SCAS actuators from extending the controls beyond the movement of the cyclic system stops. Two rotary actuators, pitch and roll, are connected in parallel with the mechanical linkage, prior to the series actuators, to transmit control movement commands from the AFC.

With the AFCS disengaged, the rotary actuators and force gradients provide a force trim system for artificial control feel. Two transducers, pitch and roll, are connected between airframe structure and respective control system to sense control system stick movement for the AFCS.



BELL 212 Pilot Training Manual

Anti-Torque Controls

A system of linkage transmits movement from the control pedals to the tail rotor. Operation of the pedals provides boosted pitch change of tail rotor blades to control the torque and resultant heading control of the helicopter. Pedal position may be adjusted by depressing and turning a knob on the cabin floor. The anti-torque system primary stops are located in both pedal adjuster assemblies.

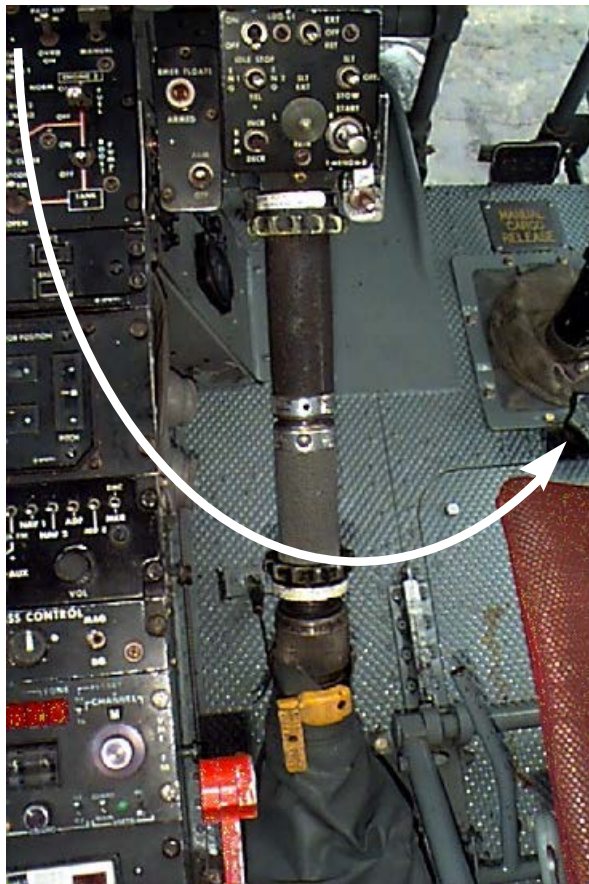


Figure 11-24 Pedal Adjustment

A series actuator (Yaw) is connected in series with the mechanical linkage prior to the crank/lever installation and transmits control movement commands from the automatic flight control system (AFCS) to the mechanical flight control system.

A rotary actuator (Yaw) is connected in parallel with the mechanical linkage. With the AFCS disengaged the rotary actuator and force gradient provides a force trim system for artificial feel. With AFCS engaged, the rotary actuator can be electrically motored so as to change control movements and maintain a reference attitude. A transducer connected between the airframe structure and control system, senses control pedal movement for the AFCS. A single hydraulic servo actuator provides a hydraulic boost to the controls and is powered by system No. 1.

Synchronized Elevator

The synchronized elevator, consisting of two negative lift airfoils, is mounted on tail boom. It is connected by mechanical linkage to the fore/aft cyclic control system at the aft horn of the swashplate. To equalize the down load on both elevators, the trailing edge of right elevator is approximately 4° lower than left elevator. Fore and aft movement of the cyclic stick changes the angle of attack of the elevator which aids in controllability of the helicopter and lengthens the CG range. Elevator trailing edge moves down when the cyclic is moved aft.



Figure 11-25 Synchronized Elevator

Campbell
Helicopters



BELL 212 Pilot Training Manual

THIS PAGE INTENTIONALLY LEFT BLANK