AVIM 103D

Aircraft Steering Systems
Key Steering Needs

• Pedals actuate steering gear and rudder
  – Large A/C may also have separate steering wheel
• Extended steering gear needs to be straight ahead for touch down and gear stowage.
• Needs to steer when weight on wheels (WOT)
• Needs to allow rudder action when locked straight ahead or stowed
Steering Systems

• Two basic types
• Open - found on conventional geared aircraft
• Closed - most common, pedals, third gear and rudder are looped in the system
Steering Systems

• Open loop system
Steering Systems

• Closed Loop System
Steering Systems

• In open loop cable systems there are pedal return springs to maintain cable tension
• Tail wheels are usually attached to rudder post assembly via bell cranks and springs
Steering Systems

• Tailwheels can be fully castoring, or steerable and castering
• Castering pivot must be vertical, or gear can get stuck
Steering Systems

• Smaller nose wheel systems use a Whiffle tree and mechanical linkage to close the "loop"
• Larger aircraft use hydraulic power steering systems
• In most nose wheel aircraft there is a shimmy damper that eliminates nose wheel shimmy
Steering Systems

• Nose wheel shimmy is similar to control surface flutter, it can tear a nose gear off in less than a second

• Two basic types of steering dampers are
  – Piston
  – Vane
Steering Systems

• Both types operate by creating chambers on either side of a moveable plate
• Due to hydraulic lock the plate cannot move unless a small metering hole is introduced
Cessna 152 Nose Gear
Nose wheel
De Havilland DH.82 Tiger Moth Tail Wheel
• XP Modifications Inc
• XPM Tail Wheel, features a 500x5 tire mounted on a specially designed assembly that keeps bearings and key wheel parts up and out of soft sand and mud.
• Advantages provided by the large tailwheel:
  Smooth operations
  • Less drag on soft ground
  • Better taxi visibility
  • Shorter take-off rolls
  • Improved ground handling
  • Improved maneuverability
Figure 63. Disengaging device
5-46. A steerable tailwheel, mounted in a tapered tubular spring strut, comprises the Models 180 and 185 tail gear. The tubular spring strut is mounted in rubber bushings to cushion vibration. The tail wheel is steerable, in response to rudder pedal actuation, through an arc of 24° each side of neutral and is free-swiveling beyond this travel. The tailwheel itself on early Model 180 airplanes is a Goodyear wheel assembly. During 1953, the tailwheel was changed to a Goodrich wheel assembly, which is the current one used. Both of these are size 6" S. C. assemblies. The Model 185 is equipped with a Scott 10" wheel assembly.

Note
Details of tailwheel assemblies are shown in figure 5-21.

1. Hose
2. Spring
3. Bolt
4. Clevis Pin
5. Spring Fitting
6. Washer
7. Nut
8. Bushing
9. Washer
10. Cotter Pin
11. Bolt
12. Bolt
13. Tailwheel Assembly
14. Link
15. Nut
16. Cotter
17. Spring
18. Tube
19. Bearing
20. Upper Dust Cap
21. Formica Washer
22. Arm Assembly
23. Washer
24. Staking Pin
25. Spacer
26. Spring
27. Tailwheel Fork
28. Bearing
29. Spacer
30. Grease Retainer
31. Washer
32. Cotter Pin
33. Nut
34. Axle
35. Lockwasher
36. Spacer
37. Washer
38. Nut
39. Cotter Pin
40. Spacer
41. Lower Dust Cap
42. Dust Cap
43. Washer
44. Spacer
45. Bracket
Steering for Piper Retractable Gear

- Steering bellcrank
- Steering arm
- Roller
- Steering rod
- Shimmy damper
Turn Limits
5-42. Nose wheel steering is accomplished through use of the rudder pedals. On all models except the 182 (1962 and on), two spring-loaded push-pull tubes connect the rudder bars to the nose gear. On the 182 (1962 and on), a steering bungee links the nose gear to a bellcrank which is operated by push-pull rods connected to the rudder bars. Steering is afforded up to approximately 10° each side of neutral, after which brakes may be used to gain a maximum deflection of 30° right or left of center. Flexible boots seal the fuselage entrance of the steering tubes or bungee. A sprocket-operated screw mechanism to provide rudder trim on the 182 (1962 and on) is incorporated at the aft end of the bungee. The trim system is discussed in Section 19.

5-43. **STEERING TUBE AND BUNGEF ASSEMBLIES** are spring-loaded and should not be disassembled internally. The steering tubes are connected by clevises to rod ends extending from the steering arm assembly on the nose gear and by a ball joint connection at the rudder pedal crossbars. The steering bungee is connected to the steering torque arm by a bearing end assembly and to the steering bellcrank by a rod end.

5-44. **ADJUSTMENT OF NOSE WHEEL STEERING.** Since the nose wheel steering system, rudder system, and rudder trim system are interconnected, adjustments to one system may affect the others. Section 10 contains rigging instructions for the nose wheel steering system as well as the rudder and rudder trim systems.
Cessna 150

1. Shimmy Damper Arm
2. Nose Gear Shock Strut
3. Engine Mount
4. Roll Pin
5. Firewall
6. Steering Tube Boot
7. Steering Tube
8. Bolt
9. Axle Bolt
NOTE

Shimmy damper design and mounting, shorter strut length, torque link design and mounting, and steering arm design are changes which have been made on the different models according to their date of manufacture.

1. Bolt
2. Strut Assembly
3. Bolt
4. Rl Steering Tube
5. Lf Steering Tube
6. Clamp
7. Bolt
8. Rod End
9. Steering Arm Assembly
10. Shimmy Damper Arm
11. Strut Clamp Cap
12. Shimmy Damper
13. Rivet
14. Nut
15. Ball Joint
16. Check Nut
17. Clevis
18. Wheel

CAUTION

When installing cap (11), check the gap between the cap and the strut fitting before the attaching bolts are tightened. Gap tolerance is .010" minimum and .016" maximum. If gap exceeds maximum tolerance, install shims, Part No. 0543042-1 (.016") and Part No. 0543042-2 (.032"), as required to obtain gap tolerance. Replace the cap if gap is less than minimum, again using the shims to obtain proper gap. Install shims as equally as possible between sides.
Cessna 182 1962 and On

NOTE
Unshaded parts of the nose gear turn as the nose gear steering system is operated on the ground, but do not turn while airborne. As the lower strut extends, a centering block on the upper torque link contacts a flat spot on the bottom end of the upper strut, thus keeping the lower strut and wheel from turning.

1. Bolt
2. Nut
3. Upper Forging
4. Bolt
5. Upper Strut
6. Steering Bungee
7. Lower Forging
8. Upper Torque Link
9. Bolt
10. Lower Torque Link
11. Torque Link Fitting
12. Nose Gear Fork
13. Wheel and Tire
14. Bolt
15. Bolt
16. Steering Collar
17. Screw
18. Bolt
19. Steering Torque Arm
20. Shimmy Damper
21. Bolt
Cessna 182 Rudder Control
Large Aircraft Nosewheel Steering
Figure 66. Typical nose wheel shimmy damper
Steering Systems

• Larger aircraft must use some form of power assist, or full power steering system
• Hydraulic power is used almost universally
• There can be either
  – a separate nose wheel steering wheel
  – a rudder pedal nose wheel steering system
  – a mix of both
Steering Systems

• Any time a hydraulic power/boost/assist system is used there must be some form of a follow-up differential control system

• This functions by disengaging the hydraulic actuator after the nose wheel has pivoted the desired amount
Steering Systems

• Dual Piston Steering Damper
• Oleo actuated shut off valve prevents steering when strut extended
• Self centering device insures that nosegear is centered for retraction
• Control cable moves bevel gears in differential control (Followup)
Steering Systems

• Orifice check valves are installed for shimmy damper action

• Compensator valve maintains small positive pressure for two reasons:
  – Prevents cavitation if wheel is moved suddenly
  – Controls thermal expansion

• Solenoid shut off valve allows inter-connection for towing, and failure
Differential Follow-up Steering Control

A. Control handle
B. Manual control gear
C. Pinion gears
D. Actuating mechanism gear
E. Nose gear strut
F. Actuating cylinders
G. Selector valve
H. Operating arm
Steering Systems

- The steering input is opposite the steering action therefore a gearset must be used to reverse the direction of the input or the output.
- The steering input unbalances the compensating device and the steering action rebalances it.
Differential Follow-up Steering Control
Differential Follow-up Steering Control
Steering Systems

• The steering input is the same as the steering action
• Again the steering input unbalances the compensating device and the steering action rebalances it.
Steering Systems

• In most cases the large aircraft dual system steering will allow for limited steering from the rudder pedals while allowing for more range from the cockpit steering assembly
• There may be a steering wheel lock out above certain speeds
• They may combine the differential steering control with the steering damper
Shimmy Damper
Shimmy Damper

- Piston type
Figure 6-16. A shimmy damper installed between the nose wheel cylinder and piston absorbs the shimmying vibrations by the transfer of hydraulic fluid from one side of the piston to the other through the bleed hole.
Shimmy Damper

• Piston type
Shimmy Damper

• Piston type
Shimmy Damper

• Piston type
Figure 70. Shock strut torque arm
Figure 67. Double action nose wheel shimmy damper
Figure 67. Double action nose wheel shimmy damper
A. CHAMBER
B. CHAMBER
C. FLANGE KEYS
D. STATIONARY VANE
E. WINGSHAFT
F. MOBILE VANE
G. HYDRAULIC SEALS
H. ORIFICE
Shimmy Damper

- Vane Type
Shimmy Damper

- Vane Type
Shimmy Damper

• Vane Type
Figure 6-17. Hydraulically operated nose gear steering cylinders allow the pilot to steer the airplane and also serve as shimmy dampers.
Piper Steering (PA28R)

- Roller alignment guide is disconnected from track while a/c is on the ground
- Steering rods cause bellcrank to pivot at center
- Bushings on steering arm serve as a bearing surface for turning the steering arm
- Torque is fed down through the center of strut to turning collar
Cessna Bungee Steering

• Rudder pedal extensions attached to steering bellcrank complete rudder "circuit" since it is impossible to put cables under compression
• Always inspect rubber boots for CO leakage
• Rudder pedals interconnect with rudder, nosewheel steering and rudder trim
• Rigging order: Rudder, nosewheel steering, rudder trim
Cessna Bungee Steering

• Functioning: On Ground:
• Initial Movement of Pedal
• Turning force is applied to steering bellcrank (whiffletree)
• Rudder moves by cable actuation
• Spring bungee is compressed at this time and nose gear does not turn much until rolling
Cessna Bungee Steering

- Torque is fed down through the center of strut to turning collar
Cessna Bungee Steering

• In Flight:
  • Initial movement of Pedal
  • Rudder moves because action of cables through spring bungee
  • Nose wheel is locked out of system by centering cam
Cessna Bungee Steering

- Continued Movement of Pedal: Nose wheel remains locked out of system and bungee moves
- Rudder Trim Interconnect: Rudder trim prepositions rudder by means of threaded shaft which compresses spring within bungee and displaces rudder and pedal only. Since spring is compressed within the bungee, the nosewheel does not turn.
END
SECTION
FOUR