Boeing 707

Nose Wheel Steering

Training manual

ATA 32

Contact address for

course registrations
course schedule information

Aviation Competence Centre
info@aviationcompetencecentre.nl

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1. GENERAL.

The nose gear steering system allows to rotate the nose wheels 60° either side of the straight forward position. Steering is obtained by turning the shock strut inner cylinder relative to the outer cylinder by means of two steering cylinders. The steering cylinders are positioned at the lower end of the shock strut. They rotate a steering collar about the shock strut outer cylinder. Steering collar movement is first transmitted to a towing collar by a steering disconnect link and, from there, to the shock strut inner cylinder by torsion links. The towing collar is provided with a lug to attach a towing bar. When it is disconnected from the steering collar, it rotates freely around the shock strut.

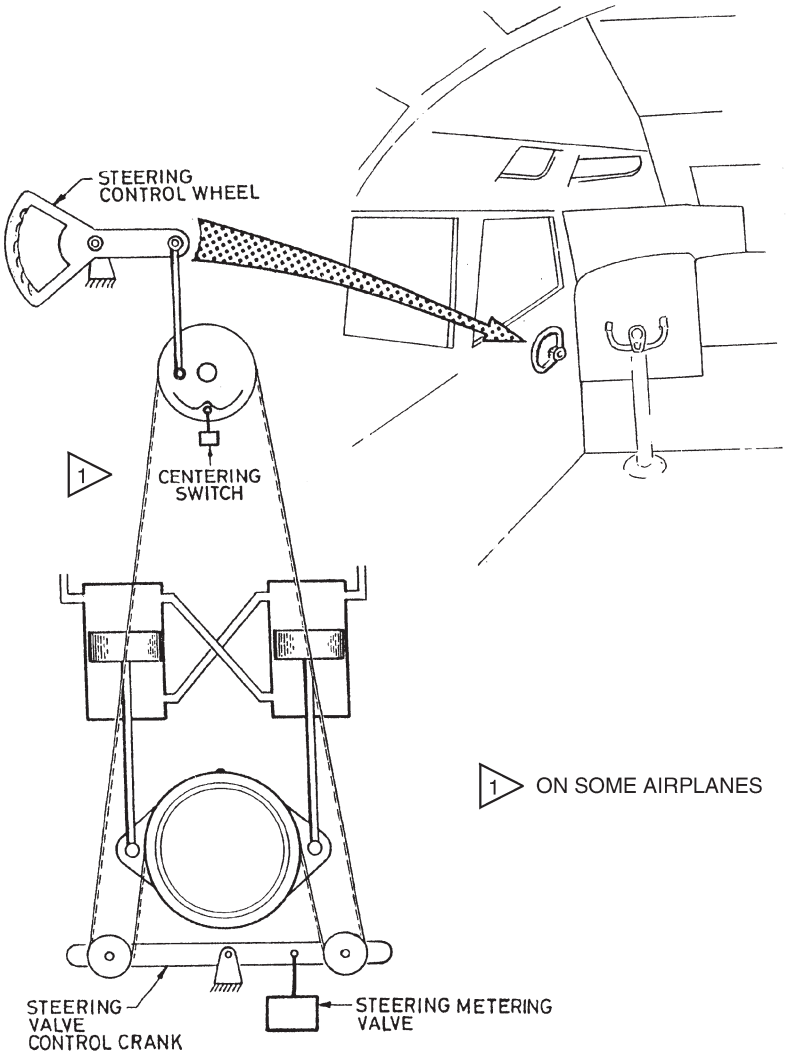
Operation.
The nose gear steering system is operative only when following conditions are fulfilled:

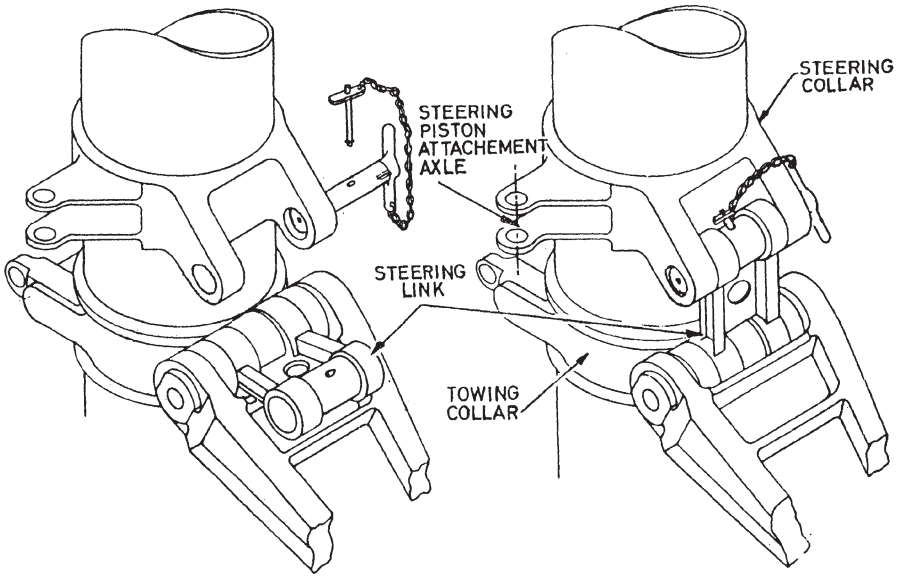
- Utility hydraulic pressure available,
- Landing gear lever control handle down,
- Nose gear down and locked,
- Nose gear shock strut compressed at least 4 inches.

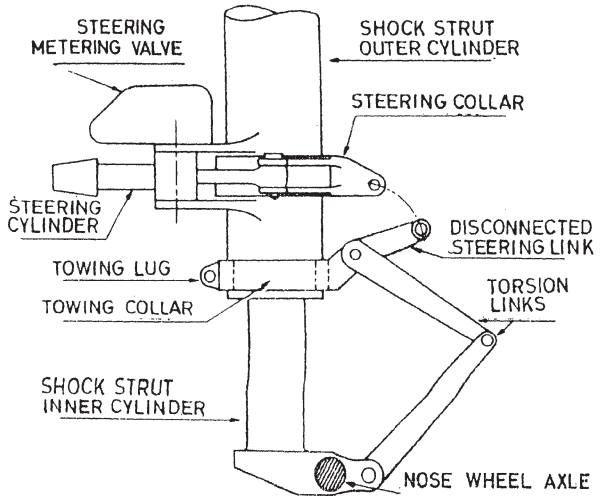
The steering control wheel must be held during turns, otherwise the nose wheel will automatically return to neutral because of the caster effect.

In the event of hydraulic pressure failure to the nose gear steering system, the gear will automatically caster freely, allowing directional control of the airplane by use of engines, brakes and rudder. Using maximum steering angle turn imposes extremely high stresses in the outer cylinder of the main gears in the area of the torsion link lugs. Continued practice of turning at the maximum angle will reduce the service life of the gear considerably. Tests and analyses revealed that reduction of the maximum Steering angle by about 10’ and omission of any braking on the inner gear during these sharp turning angles will provide a fatigue-free service potential corresponding to the lifetime of the airplane. For these reasons, it is recommended:

- Use maximum steering angle only if the turn is absolutely not feasible at reduced angle.
- Limit turns to 50° steering angle, and whenever possible use smaller, steering angle.
- Do not use differential braking in order to aid nose wheel steering.
- Do not increase steering angle above maximum steering angle while towing the aircraft with nose gear torsion links disconnected.
  The maximum steering angle is indicated by red stripes painted on the fuselage nose.







NOSE WHEEL STEERING - GENERAL

2. HYDRAULIC CIRCUIT.

The steering cylinders receive hydraulic pressure from the utility system through the landing gear down line, i.e. the landing gear selector handle must be in down position. A steering shutoff valve, operated by a quadrant installed on the nose gear left trunnion prevents down line pressure from entering the system as long as the nose gear is not completely extended. Pressure is distributed to the steering cylinders through a steering metering valve. Ibis valve is a sliding plunger type valve, spring-loaded in neutral position. In neutral position, a pressure of 70 to 130 psi, supplied by a snubbing compensator incorporated to the valve, is applied on both sides of the steering pistons to provide shimmy damping. The compensator consists of a spring-loaded piston and relief valve assembly. It is always kept full of fluid by a direct bleed passage from the inlet pressure port. When the valve plunger is moved, pressure is directed to opposite ends of the two steering cylinders. So one piston moves forward while the other moves backward. Return fluid from the steering cylinders flows back to the utility hydraulic reservoir through the snub compensator. Restrictors limit rotation rate of the collar which also provide for shimmy damping. Check valves incorporated between each cylinder pressure and return line allow snub compensator pressure to enter the cylinders during sudden turning movements (e.g. when towing the aircraft) to prevent cavitation.

Steering Control System.
The steering metering valve is cable controlled by a steering wheel,
located in the cockpit on the pilot's side wall, and by the steering collar. When the steering wheel is turned, one cable is pulled while the other one is released. As the steering collar is linked to the nose wheels, it remains stationary as long as the metering valve is in neutral position. The steering valve control crank pivots and moves the valve plunger. Hydraulic pressure is directed to the steering cylinders in such a way that the steering collar,
by rotating, progressively returns the steering metering valve towards its neutral position. The neutral position is obtained when the nose wheels reach the position corresponding to the steering wheel position.

CAUTION : ALWAYS MAKE SURE THE NOSE STEERING WHEEL IS CENTERED BEFORE RETRACTING THE LANDING GEAR. DO NOT TURN THE NOSE STEERING WHEEL UNTIL THE NOSE WHEEL IS ON THE GROUND. THE CENTERING CAMS CAN BE DAMAGED BY ATTEMPTING TO TURN THE STRUT AGAINST THE CAMS.

AT HIGH SPEED AND/OR ON WET SURFACE THE NOSE WHEEL WILL SLIP VERY EASILY EVEN IN SHALLOW TURNS.

AVOID USING NOSE GEAR STEERING DURING HEAVY BRAKING OR AT SPEEDS ABOVE 80 KIAS EXCEPT IN AN EMERGENCY. EXCESSIVE LOADS CAN RESULT IN DAMAGE TO TIRES, STRUT, AND AIRPLANE STRUCTURE.

NOTE : Releasing the steering wheel during a taxi turn will permit the nose wheels and the steering wheel to return to center or neutral due to the caster effect. The nose gear can be centered by aligning an arrow located on the steering wheel with the index placarded on the cockpit wall.

Avoid differential braking during taxi to aid nose wheel steering. Make minimum radius turns with engine power and nose gear steering. Use of brakes in turns causes excessive tire wear and strut loads.

When parking, taxi the airplane a few feet with nose gear centered to relieve strut side loads.

At low ENG RPM or with only one utility hydraulic pump operating, using nosewheel steering while extending or retracting flaps can cause flaps to stop.

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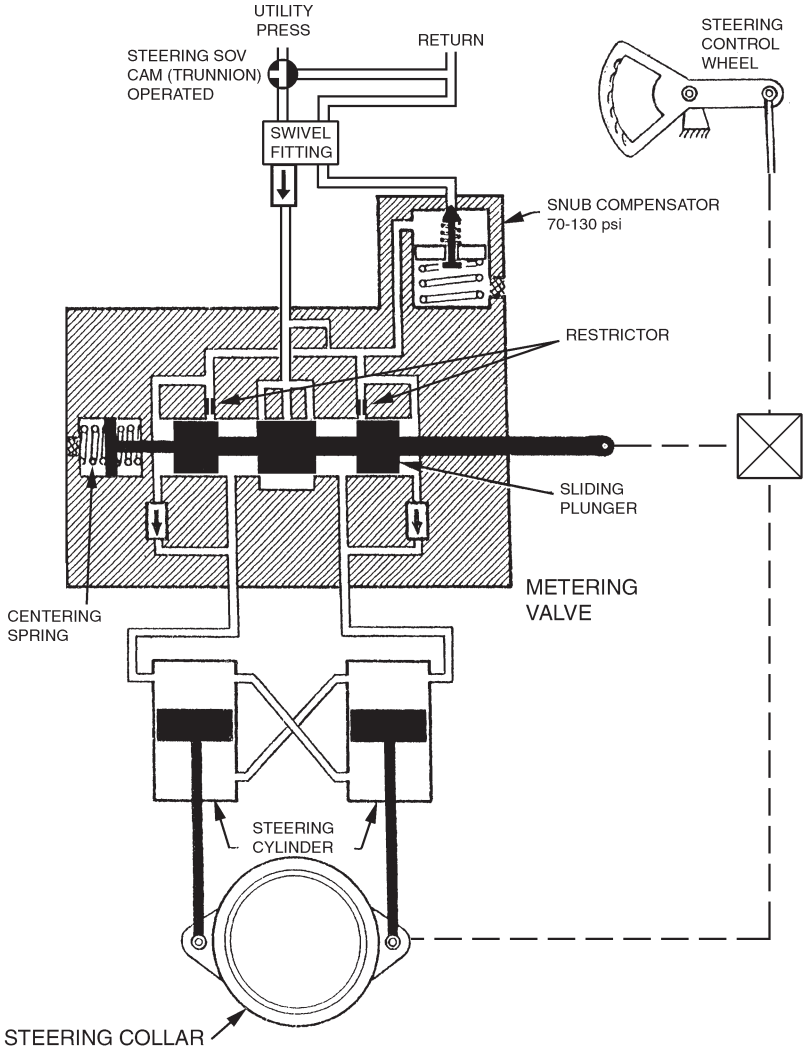
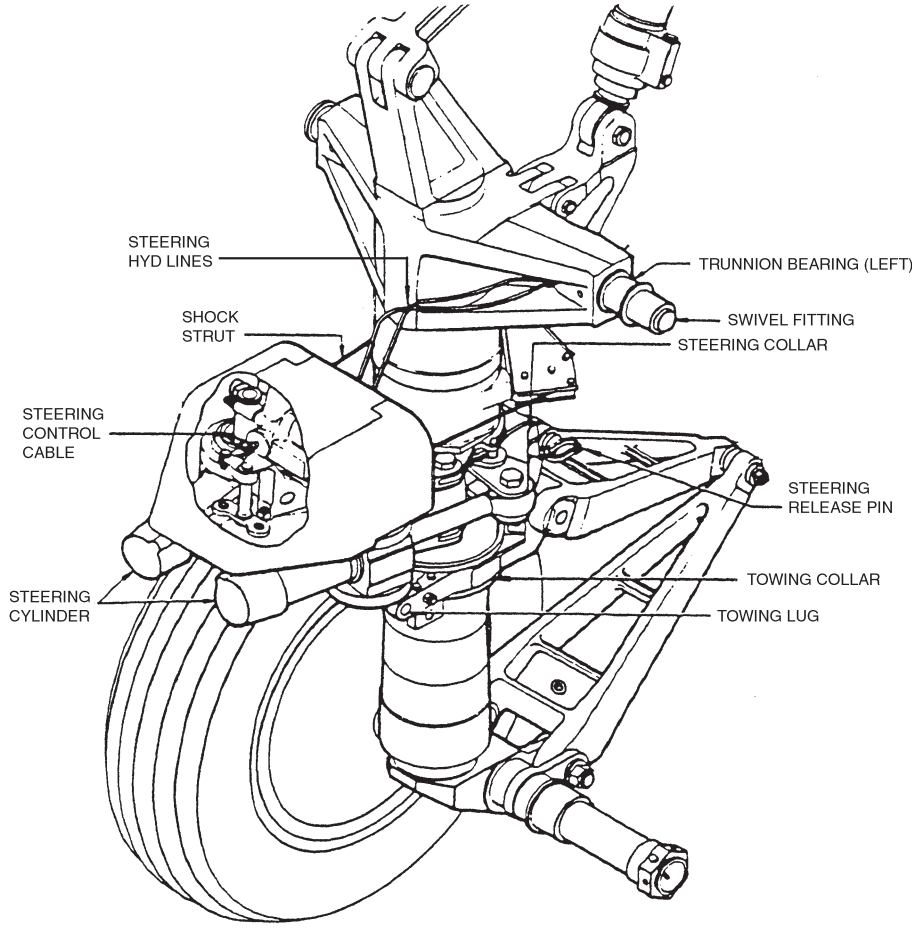




STEERING CONTROL SYSTEM

3. COMPONENT DESCRIPTION.

3.1. Steering Wheel and Cable Drum.

The nose wheel steering wheel is located on the pilot's side wall.
The steering wheel is fastened by a bracket to a structural frame. A push pull rod interconnects a crank on the steering wheel shaft and a crank on the cable drum shaft. Movement of the steering wheel is transmitted to the cable drum through the cranks and push pull rod linkage. The nose gear can be centered by aligning an arrow located on the steering wheel with an arrow on the side wall panel metal-cal.

3.2. Steering Cable and Linkage.

The nose wheel cable system consists of two cables of 3/32 inch diameter made of corrosive resistant carbon steel. The first cable runs from a turnbuckle to the control cable drum and back to the other turnbuckle. It is approximately 1.5 m long with a swaged ball at about 145 mm the center of the cable. The second cable runs from a turnbuckle down to the metering valve around the shockstrut collar and back to the other turnbuckle. It is approximately 14.5 m long with a swaged ball at about 230 mm from the center of the cable. The swaged ball is safety wire locked at the aft side of the shockstrut steering collar.

The steering collar, installed in an annulus on the shock strut outer cylinder, transmits motion from the actuating cylinder down through a link assembly to a towing collar also installed in an annulus on the outer cylinder. From the towing collar, motion is transmitted down through the torsion links to the nose wheel axle and nose wheels. The link assembly should be disconnected from the steering collar for towing. The link assembly is disconnected by pulling out the quick-release pin and removing the steering release pin.

3.3. Steering Metering Valve.

The steering metering valve is mounted on the steering cylinders with 10 close tolerance bolts, five on each steering cylinder trunnion. The metering valve directs the hydraulic fluid to the proper side of the two steering cylinders. Shimmy dampening is also provided by a snub compensator incorporated in the metering valve by retaining a certain amount of pressure on the steering cylinders.

The metering valve plunger is mechanically actuated by the cable system from the steering wheel, and is spring-loaded to a neutral position. Displacement of the plunger permits hydraulic fluid under pressure to enter the metering valve through a removable hydraulic filter in the pressure inlet passage of the valve.

The fluid enters a metering chamber consisting of various sized holes through which the fluid is metered. Metered hydraulic fluid enters the steering cylinders through mating passages of the metering valve and steering cylinders. O-rings are used to seal the mating surfaces around each passage. Fluid from the cylinders returns to the airplane system by way of a snub compensator unit within the metering valve assembly. The snub compensator consists of, a spring loaded cylinder And relief valve assembly set to relieve return pressure to the airplane system at 70 to 130 psi. The snub compensator is kept full of fluid at all times by a direct bleed passage from the pressure inlet port. Check valves are incorporated between each cylinder pressure and return line to allow the snub compensator pressure to enter the cylinder ports prevent cavitation tendencies during sudden turning forces.

3.4. Steering Shutoff Valve.

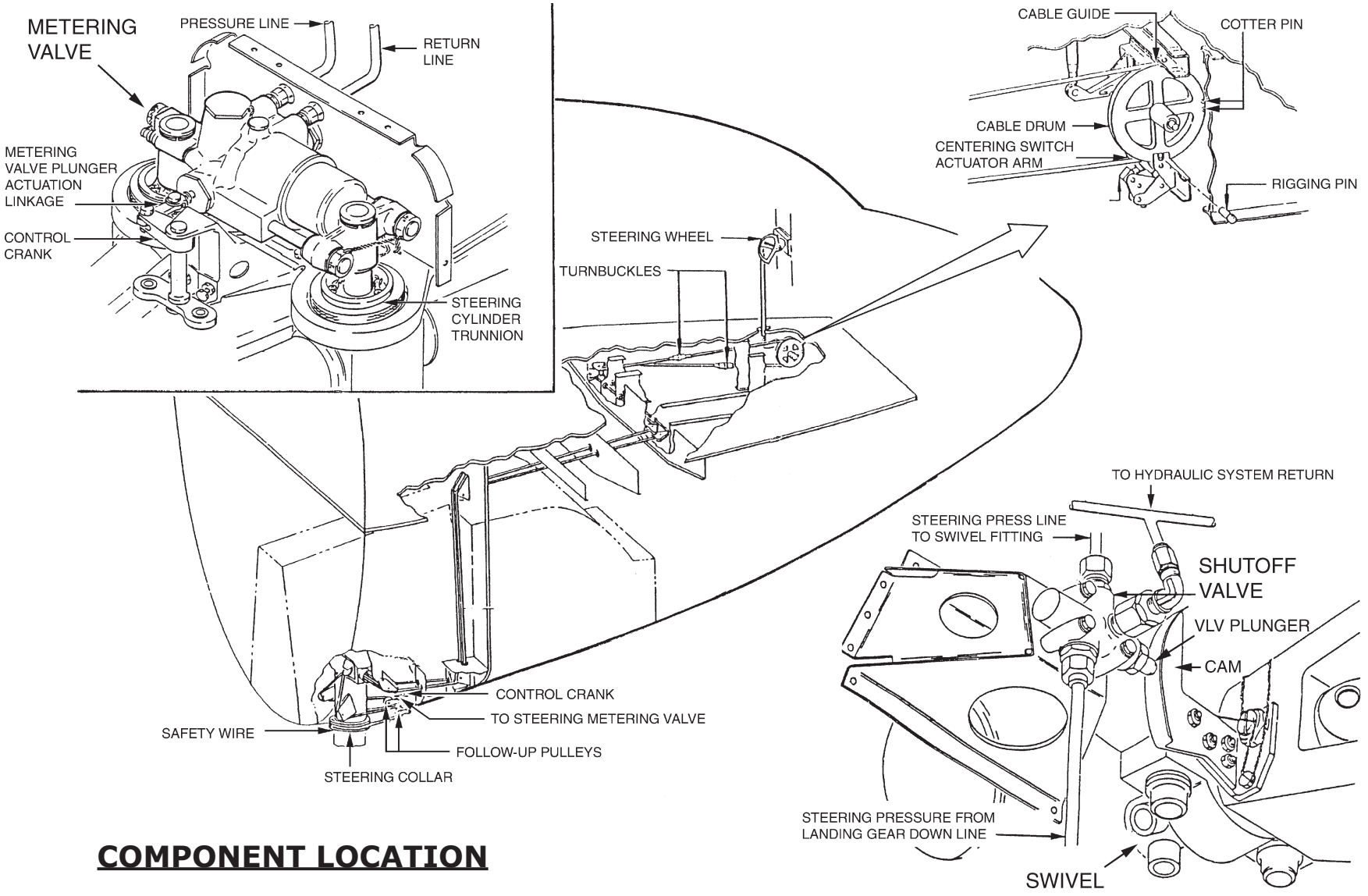
The purpose of the shutoff valve in the steering hydraulic system is to keep hydraulic pressure from entering the steering system until the landing gear is down. The valve is a sliding plunger type that is spring-loaded to the shutoff position. The valve is attached to the nose wheel well structure behind the left side of nose gear trunnion. A cam, attached to the aft left side of the nose gear trunnion, depresses (actuates) the valve plunger when the nose gear extends. When the plunger is depressed, hydraulic pressure is directed to the metering valve.

3.5. Steering Cylinder.

The nose wheel steering cylinder is a double acting hydraulic piston and cylinder assembly, using external fluid transfer tubes to effect a double acting arrangement. Mounting trunnions on the steering cylinder are attached between steering plates fixed to the outer cylinder of the oleo assembly. Bearings in the steering plates allow full swiveling action of the steering cylinder. Hydraulic oil passages are provided within the trunnions,
to mate with oil passages in the metering valve mounted directly above the steering cylinder. Close tolerance bolts and faying-surface packings are provided around the oil passages to provide a fluid tight connection.

By turning the steering wheel, motion is transferred through the cable system to the control beam and arm. The control beam and arm will displace the metering valve plunger. This will open the valve to distribute hydraulic pressure to the steering cylinders. Hydraulic pressure will cause the steering cylinder pistons to rotate the nose gear by way of steering collar and torsion links. The motion of the steering collar also actuates the follow up cables.
The follow up cables will move and reposition the control beam and arm.
This will close the control valve and block the hydraulic pressure, and thus maintain the desired degree of turn. Return fluid from the steering cylinders goes back through the steering metering valve compensator, then to the hydraulic system return. The compensator maintains a small amount of pressure on the cylinders at all times to provide shimmy dampening.

Release of the steering wheel during a taxi turn will permit the nose wheels and the steering wheel to return to center or neutral due to the cornering forces. Holding the steering wheel during a taxi turn allows just enough metering to overcome the cornering forces.



COMPONENT LOCATION